COGNITIVE TRAINER CHARACTERISTICS THAT PREDICT OUTCOMES

FOR STUDENTS WITH AND WITHOUT ADHD

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Abstract

The current study utilized a quantitative, non-experimental design with multiple regression analysis of survey and archived data to examine the predictive value of cognitive trainer characteristics (degree field, degree level, cognitive trainer certification level, pre-hire cognitive test score, and personality traits) on student outcome measures of general intelligence, working memory, long-term memory, and processing speed. The study sample included 150 cognitive trainers and the archived records of 1,195 students. There were no statistically significant predictors of outcomes for students with ADHD. For students without ADHD, a trainer degree in education predicted higher long-term memory scores ($p = .002$, $sr^2 = .017$); a degree higher than a master's predicted lower long-term memory scores ($p = .004$, $sr^2 = .015$); a master trainer certification predicted higher long-term memory scores ($p = .002$, $sr^2 = .017$), and extroverted trainer personality predicted higher processing speed scores ($p = .005$, $sr^2 = .01$). Administrators of cognitive training programs may want to track trends in outcomes of students with and without ADHD who are trained by trainers with master certification, a degree in education, a post-master's level degree, or extroverted personality. Limitations of the study and suggestions for future research are discussed.

Dedication

Dedicated first to God who makes all things possible. To my husband, Jeff, for your unwavering love and tireless support over these four long years, for being as excited about my research as I am, for being the super-human fighter pilot brain and inspiration behind my love of cognitive psychology, and for never doubting my ability to do this. You have all my love, all my life, with all my heart. To my sons Cael, Lawson, and Evan for cheering me on, for eating way too many pizzas so I could study late, for understanding when I couldn't join you on an adventure because I was studying, for rescuing me from technological disasters, and for reminding me that someday you would call me "Dr. Mom"! I hope all three of you do this someday. I love you. To my parents who modeled a lifelong love of teaching and learning; to my mom (Katie) for being my first (and best) professional mentor and for always reminding me that "You can do it, Louie!"; to my dad (Bill) for loving me no matter what; to my dad (Jim) whose spirit of accomplishment will never stop inspiring me…I wish he could have lived long enough to see me do this; to my mom (Maureen) for setting the bar higher than anyone else…I just had to catch up; to my incredible in-laws Linda and Rick for saving a rapidly sinking ship so I could finish. I love you all.

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CHAPTER 1. INTRODUCTION

Background of the Problem

Cognitive training is a broad term referring to interventions that enhance specific cognitive skills through repeated engagement in targeted mental tasks (Rabipour & Raz, 2012). Grounded in the assumption of neuroplasticity, cognitive training programs are designed to improve general intelligence as well as refine neural processes such as working memory, attention, and processing speed. Unlike tutoring and other academic interventions for acquiring content knowledge, cognitive training programs are designed to improve thinking and learning across domains through enhanced cognitive flexibility (Atkins, Bunting, Bolger, & Dougherty, 2011). With a clinical reach beyond computer-delivered "brain games", cognitive trainers create individualized interventions for students that target specific cognitive deficits identified through pretesting with standardized assessments such as the Woodcock-Johnson III Tests of Cognitive Abilities (Woodcock, McGrew, & Mather, 2007) or the Gibson Test of Cognitive Skills (Gibson, 2000). Using a set of intensive game-like mental tasks, trainers deliver interventions one-on-one to students during one-hour sessions five days per week for a duration of 12 to 24 weeks (Gibson, 2007). The current study examined how cognitive trainer characteristics (personality traits, college major, degree level, certification level, pre-hire cognitive test score) predicted outcomes on measures of working memory, long-term memory, processing speed, and general intelligence for students with and without ADHD. Prior research suggested that such characteristics are all associated with instructor quality, student achievement, student persistence in intervention programs; and instructor use of

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ADHD intervention strategies (Bowers, 2006; Carlson, Lee, & Schroll, 2004; Charlebois, Vitaro, Normandeau, Brendgen, & Rondeau, 2004; Croninger, Rice, Rathbun, & Nishio, 2007; Fenderson, 2011; Garcia, 2010; Kneipp, Kelly, Biscoe, & Richard, 2010; Small, 2006). However, it is not clear how instructor traits predict cognitive training outcomes. Furthermore, over 33% of students enrolled in a certain proprietary network of cognitive training programs in 2011 had been previously diagnosed with ADHD; and 67% of students reported problems with attention prior to enrollment (Gibson, 2011). Therefore, it was valuable to examine the association of cognitive trainer traits with learning outcomes of students with and without ADHD.

The current study was situated within in the field of educational psychology as cognitive and social cognitive lenses have framed over 98% of educational psychology research conducted since 1995 (Mitchell & McConnell, 2012). Not only do educational psychology researchers examine individual cognitive processes such as attention (Swanson, 2011) and memory (Swanson, 2008), they also study how innate skills and learning experiences influence cognitive performance (Hergenhahn & Henley, 2014). Additionally, students with ADHD exhibit individual learning differences due to deficits in attention, working memory, and executive control (Brown, 2006), so a focus on outcomes for students with ADHD provided insight on the trainer characteristics needed for creating the positive learning conditions that contribute to their learning gains. With 11% of children in the United States diagnosed with ADHD (Visser et al., 2013), it was critical to identify factors that promote and enhance their academic success. Therefore, an examination of the trainer characteristics that predict cognitive training outcomes for

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students with and without ADHD was aligned with current research trends, and was an appropriate task for a researcher in the field of educational psychology.

Statement of the Problem

Extant research has demonstrated support for the efficacy of cognitive training programs in both computer-based and face-to-face environments (Gibson, 2009; Holmes et al., 2009; Klingberg et al., 2005; Melby-Lervag & Hulme, 2013; Sonuga-Barke et al., 2013; Wegrzyn, Hearrington, Martin, & Randolph, 2012). However, prior studies focused on factors related to intervention tasks that predicted cognitive training gains rather than the characteristics of cognitive trainers that may predict training outcomes. It was unknown how the characteristics of cognitive trainers might predict training outcomes for students with or without ADHD. Through the lens of social cognitive theory, the current research examined the predictive variables of cognitive trainer characteristics on training outcomes for students with and without ADHD. Specifically, the study examined if the cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predicted learning outcomes in general intelligence, working memory, long-term memory, and processing speed as measured by the Woodcock Johnson III-Tests of Cognitive Abilities for students with and without ADHD.

Purpose of the Study

The purpose of the current study was to investigate the characteristics of cognitive trainers that predicted cognitive training outcomes for students with and without ADHD. Although prior research had demonstrated support for the efficacy of cognitive training programs (Gibson, 2009; Holmes et al., 2009; Klingberg et al., 2005; Melby-Lervag & Hulme, 2013; Sonuga-Barke et al., 2013; Wegrzyn, Hearrington, Martin, & Randolph, 2012), the factors unrelated to treatment tasks that predict cognitive training gains have not been identified. Further, it remains unclear how the characteristics of cognitive trainers might predict training outcomes. Knowledge of the predictive value of these trainer characteristics (including college degree and level, cognitive training certification level, personality traits, and pre-hire cognitive test scores) may assist program administrators in maximizing the benefits of the training for children and adolescents with ADHD through targeted trainer recruitment and appropriate matching of trainer and student. Because over 33% of students enrolled in a certain proprietary network of cognitive training programs in 2011 had been previously diagnosed with ADHD; and 67% of students reported problems with attention prior to enrollment (Gibson, 2011), it was important to examine the association of cognitive trainer traits with learning outcomes of students with and without ADHD.

Significance of the Study

Dominated by efficacy studies, past research on cognitive training revealed improvements in attention (Gibson, 2009; Rabiner, Murray, Skinner, & Malone, 2010),

memory (Beck, Hanson, & Puffenberger, 2010; Carpenter, 2009; Gibson et al., 2011), and reading comprehension (Shalev, Tsal, & Mevorach, 2007), as well as a reduction in hyperactivity (Vander der Oord et al., 2012). Prior studies showed improvements in attention, processing speed, working memory, long-term memory, phonemic awareness, auditory and visual processing, logic and reasoning, sensory motor skills, oppositional behavior, general intelligence, and school performance (Carpenter, 2009; Jedlicka, 2012; Luckey, 2006; Luckey, 2009; Pfister, 2013). Prior research had also indicated a relationship between instructor characteristics and student achievement in a variety of settings including schools (Carlson, Lee, & Schroll-Westat, 2004; Edmonds, 2010; Garcia, Kupczynski, & Holland, 2011; Kneipp, Kelly, Biscoe, & Richard, 2010), tutoring (Putra, 2013), corporate training (Ghosh, Satyawadi, Joshi, Ranjan, & Singh, 2012), and mental health (Charlebois, Vitaro, Normandeau, Brendgen, & Rondeau, 2004; Siqueland et al., 2000). The current study added to the scientific knowledge base on cognitive training by filling a gap in the literature with an examination of trainer characteristics that predict outcomes for students with and without ADHD; and also added to the knowledge base on the relationship between instructor characteristics and student outcomes by examining that relationship in the cognitive training setting. Given the theoretical support for relationships as moderators to learning and the development of self-efficacy for learning (Bandura, 1997; Schunk & Miller, 2002), this relationship should indeed have been examined in the context of cognitive training.

Educational psychology researchers examine individual cognitive processes such as attention (Swanson, 2011) and memory (Swanson, 2008), as well as how innate skills

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and learning experiences influence cognitive performance (Hergenhahn & Henley, 2014). By focusing on the relationship between the characteristics of cognitive trainers and student outcomes, the current study added to the research base by examining whether the efficacy of cognitive training interventions is determined by procedural or curricular factors alone. Because students with ADHD exhibit individual learning differences due to deficits in attention, working memory, and executive control (Brown, 2006), a focus on outcomes for students with ADHD helped gain insight on the trainer characteristics needed for creating the positive learning conditions that contribute to their learning gains. Further, the current study was situated within social cognitive theory based on the potential of cognitive training to facilitate the development of student self-efficacy for academic achievement through the use of mastery experiences and verbal persuasion. Findings from this study were sought to establish support for viewing the cognitive training field through a social cognitive lens, which broadens the theory's educational application from traditional learning environments. The dynamic feedback inherent in one-on-one trainer facilitation of mastery experiences should illustrate the key influence of verbal persuasion on student outcomes and support Bandura's (1993) contention that cognitive development is inextricably related to social relations.

Knowledge of the predictive value of cognitive trainer factors may assist program administrators at cognitive training centers in maximizing the benefits of the training for students with ADHD through appropriate hiring of cognitive trainers, and ideal matching of trainer and student. If personality traits do indeed predict student outcomes, then center administrators may choose to assess personality profiles during pre-employment

screening. In addition, administrators may find that assigning a trainer with a particular combination of characteristics is a best practice for maximizing gains for students with ADHD. The study sought to identify trainers with combinations of characteristics that predict minimal gains from training. Due to the out-of-pocket expense for cognitive training frequently incurred by parents, this information is especially important for cognitive training centers to ethically promote parent satisfaction and student success.

Research Design

The study employed a non-experimental, quantitative design with a multiple regression analysis of archival and survey data to determine the predictive value of the trainer characteristics (personality traits, college major, degree level, certification level, and pre-hire cognitive test score) on the outcome variables of general intelligence, working memory, long-term memory, and processing speed of students with ADHD and without ADHD. The dependent variables were obtained by using the pre-test and post-test measures of working memory, long-term memory, processing speed, and general intelligence on the Woodcock Johnson III – Tests of Cognitive Abilities. Items from the Big 5 Personality Inventory were used to measure participants' personality traits, and the survey was administered online. Multiple regression (MR) analyses was used to find out which trainer characteristics predicted learning outcomes for all students, followed by a split file multiple regression for students with ADHD and students without ADHD. A follow-up Fisher's z test was used to compare the R-squared values for each MR model, and to analyze the weights of each predictor variable in both groups.

Research Questions and Hypotheses

Primary Research Question

Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in general intelligence, working memory, long-term memory, and processing speed for students with and without ADHD?

Research Question 1

Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *general intelligence* for students with and without ADHD?

Null hypothesis. There is no significant correlation among variables. All of the coefficients are zero and none of the variables significantly predicts general intelligence gains in the program: H_0: $\beta_1 = \beta_2 = ... = \beta_5 = 0$

Research Hypothesis 1.1 Trainer personality type is a significant predictor of general intelligence gains from the program: H_1: $\beta_1 \neq 0$

Research Hypothesis 1.2. Trainer educational level is a significant predictor of general intelligence gains from the program: H_2: $\beta_2 \neq 0$

Research Hypothesis 1.3. Trainer certification level is a significant predictor of general intelligence gains from the program: H_3: $\beta_3 \neq 0$

Research Hypothesis 1.4. Trainer pre-hire cognitive test score is a significant predictor of general intelligence gains from the program: H_4: $\beta_4 \neq 0$

Research Hypothesis 1.5. Trainer degree field is a significant predictor of general intelligence gains from the program: H_5: $\beta_5 \neq 0$

Research Question 2

Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *working memory* for students with and without ADHD?

Null hypothesis. There is no significant correlation among variables. All of the coefficients are zero and none of the variables significantly predicts working memory gains in the program: H_0: $\beta_1 = \beta_2 = ... = \beta_5 = 0$

Research Hypothesis 2.1. Trainer personality type is a significant predictor of working memory gains from the program: H_1: $\beta_1 \neq 0$

Research Hypothesis 2.2. Trainer educational level is a significant predictor of working memory gains from the program: H_2: $\beta_2 \neq 0$

Research Hypothesis 2.3. Trainer certification level is a significant predictor of working memory gains from the program: H_3: $\beta_3 \neq 0$

Research Hypothesis 2.4. Trainer pre-hire cognitive test score is a significant predictor of working memory gains from the program: H_4: $\beta_4 \neq 0$

Research Hypothesis 2.5. Trainer degree field is a significant predictor of working memory gains from the program: H_5: $\beta_5 \neq 0$

Research Question 3

Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *long-term memory* for students with and without ADHD?

Null hypothesis. There is no significant correlation among variables. All of the coefficients are zero and none of the variables significantly predicts long term memory gains in the program: $H_0: \beta_1 = \beta_2 = ... = \beta_5 = 0$

Research Hypothesis 3.1. Trainer personality type is a significant predictor of long term memory gains from the program: $H_1: \beta_1 \neq 0$

Research Hypothesis 3.2. Trainer educational level is a significant predictor of long term memory gains from the program: $H_2: \beta_2 \neq 0$

Research Hypothesis 3.3. Trainer certification level is a significant predictor of long term memory gains from the program: $H_3: \beta_3 \neq 0$

Research Hypothesis 3.4. Trainer pre-hire cognitive test score is a significant predictor of long term memory gains from the program: $H_4: \beta_4 \neq 0$

Research Hypothesis 3.5. Trainer degree field is a significant predictor of long term memory gains from the program: $H_5: \beta_5 \neq 0$

Research Question 4

Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes processing speed for students with and without ADHD?

Null hypothesis. There is no significant correlation among variables. All of the coefficients are zero and none of the variables significantly predicts processing speed gains in the program: H_0: $\beta_1 = \beta_2 = ... = \beta_5 = 0$

Research Hypothesis 4.1. Trainer personality type is a significant predictor of processing speed gains from the program: H_1: $\beta_1 \neq 0$

Research Hypothesis 4.2. Trainer educational level is a significant predictor of processing speed gains from the program: H_2: $\beta_2 \neq 0$

Research Hypothesis 4.3. Trainer certification level is a significant predictor of processing speed gains from the program: H_3: $\beta_3 \neq 0$

Research Hypothesis 4.4. Trainer pre-hire cognitive test score is a significant predictor of processing speed gains from the program: H_4: $\beta_4 \neq 0$

Research Hypothesis 4.5. Trainer degree field is a significant predictor of processing speed gains from the program: H_5: $\beta_5 \neq 0$

Assumptions and Limitations

As inherent in a modern quantitative design, this study accepted the assumptions of post-positivism critical realism; that is, the goal of science is to uncover reality while acknowledging the impossibility of the task (Trochim, 2000). This study also assumed that the etiology of ADHD stems from an impaired executive management system that coordinates and regulates cognitive processes that encompass activation, focus, effort, emotions, memory, and actions (Brown, 2006). The executive functions like planning, forward thinking, working memory, and inhibition of responses are critical for academic

performance, self-regulation, long-term memory, theory of mind, and psychosocial well-being (Bryck & Fisher, 2012). This study further assumed that cognitive training is an effective intervention for the remediation of cognitive skills and associated learning problems for student with ADHD. It was not an efficacy study but, instead, examined conditions in which cognitive training is most effective. Finally, the nature of analyzing archival student data presented limitations to study designs. That is, the data did not come from randomized groups, there was no control group, and the fidelity of the intervention across cognitive training centers was not controlled by the researcher.

Definition of Terms

ADHD. Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized as a persistent pattern of inattention, impulsivity, and/or hyperactivity that affects functioning and quality of life in social, academic, and occupational environments (APA, 2013).

Agreeableness. Agreeableness is a Big 5 personality trait characterized by good-naturedness, trusting disposition, helpfulness, altruism, and an ability to forgive easily. It is contrasted with cynicism, suspiciousness, abrasiveness, and a sense of vengeance (Widiger & Costa, 2013).

Cognitive Trainer. A cognitive trainer is a clinician who delivers cognitive training one-on-one to a student.

Cognitive Training. Cognitive training refers to interventions that enhance cognitive skills through repeated engagement in targeted, game-like mental tasks (Rabipour & Raz, 2012).

Conscientiousness. Conscientiousness is one of the Big 5 personality traits characterized by organization, persistence, ambition, self-directedness and motivation to meet goals. It is contrasted with carelessness, lack of reliability, negligence, and laziness (Widiger & Costa, 2013).

Extraversion. Extraversion is one of the Big 5 personality traits characterized by high social ability, activeness, talkativeness, and optimism. It is contrasted with quietness, introversion, aloofness, and a reserved disposition (Widiger & Costa, 2013).

General Intelligence. General intelligence is the basic cognitive ability that underlies the ability to perform all other intellectual tasks (APA, 2007).

Long-term Memory. Long term memory is a cognitive skill that includes the ability to store, consolidate, and retrieve information over long periods of time (Schneider & McGrew, 2012); and the ability to perform a skilled task, to recall events, and to reproduce facts a long time after they were learned (APA, 2007).

Neuroticism. Neuroticism is a Big 5 personality trait characterized by psychological distress, negative affect, self-consciousness, and anxiousness. It is contrasted with calmness, resistance to anger, comfort with social situations, and the ability to tolerate frustration (Widiger & Costa, 2013).

Openness. Openness is one of the Big 5 personality traits characterized by actively seeking and appreciating experiences and ideas to satisfy mere curiosity. It is

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contrasted with closedness, which is characterized by rigidity of beliefs and conventionality in attitudes (Widiger & Costa, 2013).

Processing Speed. Processing speed is a cognitive skill that characterizes the ability to perform cognitive tasks quickly and fluently (Schneider & McGrew, 2012).

Working Memory. Working memory is a cognitive skill that includes retaining verbal information, manipulating visual information, and deploying attention between them while ignoring distractions (APA, 2007; Schneider & McGrew, 2012).

Expected Findings

The expected finding from this study was that cognitive trainer personality traits would have significant predictive value on student training gains. Prior research indicated that teacher personality style is a significant predictor of academic achievement, accounting for 87% of variance in language arts scores, 97% of variance in science scores, and 92% of variance in social studies scores (Garcia, Kupczynski, & Holland, 2011). Further, there was theoretical support for relationships as moderators to learning and the development of self-efficacy for learning (Bandura, 1997; Schunk & Miller, 2002). Therefore, the variable of trainer personality traits was hypothesized to be the largest predictor of student gains in general intelligence, working memory, long-term memory, and processing speed.

Organization of the Remainder of the Study

The remainder of the study is organized beginning with a literature review in Chapter 2. The chapter opens with an introduction to the literature review, followed by a description of the theoretical orientation for the study. Then, the chapter concludes with a detailed review, synthesis, and critique of the existing literature on cognitive training and trainer traits that predict student outcomes. Chapter 3 presents the study's methodology including a detailed description of the research design, target population and sample, study procedures, instruments, research questions and hypotheses, method of data analysis, and expected findings. In Chapter 4, the results are presented, first in summary format followed by detailed analyses with charts and descriptives. Finally, Chapter 5 discusses the findings from the study with interpretations, implications, and conclusions.

CHAPTER 2. LITERATURE REVIEW

Introduction to the Literature Review

This review of the literature opens with an explanation of the theoretical orientation for the study, Bandura's social cognitive theory and the construct of self-efficacy. The chapter continues with a description of the existing literature organized by study constructs and variables related to the influence of instructor characteristics on student achievement: cognitive skill deficits in ADHD, training of cognitive skills, instructor personality, instructor education and experience, and pre-hire cognitive testing. A discussion on research methodology related to the topic is included in the synthesis and critical discussion of previous research on the topic of trainer characteristics and student outcomes.

The literature was surveyed beginning with Summon for an overall view of available resources. The initial search was followed by detailed searches using several databases accessed through the Capella University library, including ProQuest Psychology Journals, ProQuest Education Journals, ERIC, PsycARTICLES, Dissertations@Capella, Dissertations and Theses Full Text, ScienceDirect, and Mental Measurements Yearbook. Keywords used for the search included "cognitive training", "brain training", "teacher characteristics", "teacher characteristics and achievement", "instructor characteristics", "trainer characteristics", "therapist characteristics", "teaching students with ADHD", "ADHD intervention", "Bandura and ADHD", "cognitive self-efficacy", "academic self-efficacy", "relationships and ADHD", "pre-hire testing", "employment cognitive testing", "teacher personality", and "cognitive deficits in

ADHD". A majority of the literature used for the study was published in Contemporary

Educational Psychology, with additional literature published in education and psychology

journals including Educational Evaluation and Policy Analysis, Applied Cognitive

Psychology, Developmental Psychology, Developmental Science, Journal of Educational

Psychology, and Review of Educational Research.

Theoretical Orientation for the Study

The primary theoretical basis for the current study was social cognitive theory

with an emphasis on the component of self-efficacy. Bandura's (2001) social cognitive

theory is all-encompassing in its explanation of learning, development, and behavior.

Bandura describes these processes as "emergent interactive agency"; that is, cognition is

not merely a function of exposure to stimuli, but an active process of exploring and

influencing the environment. The environment includes not only the setting, but also the

people with whom students interact. Central to Bandura's theory are the self-regulatory

mechanisms—such as self-monitoring, goal-setting, and outcome expectations—that

humans develop to change, use, and adapt knowledge in social contexts for guiding

decisions and actions (Bandura, 1993). We are proactive and reflective shapers of the

environment, not just reactors to the environment. The outcomes of those actions, in

turn, create new knowledge. The agentic action of students is necessary for cognitive

training gains. They are participatory agents in the training, so the efficacy of such is

dependent upon the social interactions with the trainer and not simply upon an imparted

training paradigm.

A key component of social cognitive theory is self-efficacy, a learner's perceived ability to accomplish a task or meet a goal (Bandura, 1996). Motivational constructs underlie all learning processes and the greatest of these motivators is self-efficacy (p. 6). Self-efficacy research repeatedly confirms its superior effect on academic performance over all other motivational beliefs (Schunk, 1994). Further, self-efficacy is a greater predictor of academic achievement than actual ability (Bandura, 1993). Berry (1987) revealed through path analysis that perceived self-efficacy about cognitive ability directly influences cognitive effort and memory performance. According to Bandura, there are four primary sources of self-efficacy development: mastery experiences, verbal persuasion, vicarious experiences, and physiological responses to stress. The current study was situated within social cognitive theory based on the potential of cognitive training to facilitate the development of student self-efficacy for academic achievement through two of these self-efficacy sources: mastery experiences and verbal persuasion.

The study sought to expand the application of social cognitive theory to the cognitive training environment. In addition, examination of the dynamic influence of non-treatment variables—cognitive trainer characteristics—was expected to expand the current understanding of social cognitive theory (Bandura, 2001) as applied to cognitive training for ADHD by examining the broader social influences on executive functions in the cognitive training environment. Further, the development of students' self-efficacy for academic achievement was expected to be facilitated through success in trainer-delivered cognitive training tasks. Because self-efficacy is a necessary component for motivation to learn, success in learning hinges upon the development of this construct

(Bandura, 1996). The unique one-on-one training delivery format should have created two potential sources of self-efficacy for students: mastery experiences and verbal persuasion.

According to Bandura (1995), mastery experiences are the greatest influence on self-efficacy. Progression through a cognitive training program hinges upon mastery of each task, achieved through deliberate and targeted practice. However, another key characteristic of cognitive training is the interaction between cognitive trainers and students, as well as the intensity of task facilitation created by the cognitive trainers. Cognitive trainers provide dynamic feedback throughout each training procedure which is a vital and necessary form of efficacy-building verbal persuasion (Hattie & Timperley, 2007). Self-efficacy beliefs determine causal attributions of successes and failures, and effective instructional feedback helps shape how students make those attributions (Bandura, 1995). This phenomenon is supported by a related motivation theory— attribution theory—which assumes that students seek causal explanations for their academic successes and failures such as ability, effort, difficulty of the tasks, or luck (Schunk, 2008). Feedback that helps students attribute their performance to effort has been shown to increase student engagement and performance on the task (Dohrn & Bryan, 1994). This creates a critical role for the instructor (or cognitive trainer) since attributions of successes and failures may influence self-efficacy more than the actual causes of successes and failures (Hattie & Timperley, 2007). Therefore, participation in a trainer-facilitated cognitive training program creates the potential for students to develop academic self-efficacy not only through mastery experiences but also from

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efficacy-building verbal persuasion. Further, because positive communication from significant others and instructional connectedness are relational moderators of learning (Bandura, 1997; Martin & Dowson, 2009; Schunk & Miller, 2002), the current study sought to expand the application of self-efficacy theory to the influence of cognitive trainer characteristics on student learning outcomes.

Review of Research Literature and Methodological Literature

Cognitive Skill Deficits in ADHD

Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized as a persistent pattern of inattention, impulsivity, and/or hyperactivity that affects functioning and quality of life in social, academic, and occupational environments (APA, 2013). ADHD affects 8.8% of children (Visser et al., 2014) and 4.4% of adults (Kessler et al., 2006). Barkley, Murphy, and Fisher (2008) report that 93% of cases develop by age 12, thus impacting academic performance and social functioning throughout adolescence and into adulthood.

Although several paradigms for explaining the etiology of ADHD have been espoused, it is believed that executive function deficits are the primary feature of ADHD (Barkley, 2012; Brown, 2006). Brown (2006) proposes that individuals with ADHD present with a variety of symptoms related to an impaired system for coordinating and regulating cognitive processes including activation, focus, effort, emotions, memory, and action. These processes impact the ability to organize tasks, prioritize use of time,

sustain effort and focus, manage frustration, regulate actions, and remember information. According to Brown, two key cognitive skills impacted by ADHD are memory and processing speed.

Extant research supports the contention that executive functioning deficits are present among individuals with ADHD. In a study comparing Woodcock Johnson III test results of participants with ADHD ($n = 184$) and a control group without ADHD ($n = 88$), participants with ADHD scored significantly lower on measures of broad attention, cognitive fluency, and executive processes (McQuade et al., 2011). Similarly, using a combination of card-sorting, Stroop, no-go, and trail-making tasks to compare participants with ADHD ($n = 85$) to non-ADHD controls ($n = 97$), Martel, Nikolas, and Nigg (2007) found statistically significant differences between the groups across all executive function measures. Further, a comprehensive meta-analysis of 26 working memory studies comparing participants with ADHD and non-ADHD controls reported moderate to large impairments in both spatial and verbal working memory (Martinussen, Hayden, Hogg-Johnson, & Tannock, 2005).

Studies on processing speed deficits among participants with ADHD reveal similar results. In a study comparing ADHD participants ($n = 27$) to non-ADHD controls ($n = 27$), the control group earned statistically significant higher scores on the processing speed composite from the Wechsler Intelligence Scale for Children which requires completion of digit-symbol coding and symbol search tasks (Lewandowski, Lovett, Parolin, Gordon, & Codding, 2007). The same study also revealed parent and teacher reported deficits in executive functioning for participants with ADHD. Another study

compared participants with the inattentive-type of ADHD to three other groups, finding that scores on speed of processing tests were the discriminating factor among them (Weiler, Bernstein, Bellinger, & Waber, 2000).   Lawrence et al. (2004) demonstrated slower processing speed on both neurological tests and real-life activities among participants with ADHD. Using a matched control group design of 44 participants, researchers tested executive functions, including processing speed, during video game play and a route-following exercise at a local zoo. Participants with ADHD were slower on color-naming Stroop tasks, card-sorting tasks, and completing the routes at the zoo.

Despite the plethora of evidence for cognitive deficits in ADHD, scores on measures of general intelligence in individuals with ADHD are not consistently reported as different from the IQ scores of individuals without ADHD. In one study, Strand et al. (2012) reported a mean difference of four IQ points measured by the WISC between participants with ADHD ($n = 24$) and non-ADHD controls ($n = 32$), although not statistically significant. Consistent with the previous finding, a study on twins discordant for ADHD also revealed a non-significant 4-point difference in IQ points between twins with ADHD and twins without (Sharp et al., 2003). Schuck and Crinella (2005) concluded that general intelligence is independent from executive functions after they administered the WISC-III to 127 participants with ADHD who obtained a mean score of 105.6, which is higher—not lower—than the test standardization population mean. Therefore, prior research has not made it clear whether general intelligence is a relevant player in the evaluation of cognition among individuals with ADHD; however, investigating changes in cognitive skills following interventions for ADHD is indeed an

area of research firmly established in the educational psychology literature and supported the relevance of the current study.

Training Cognitive Skills

Cognitive training refers to interventions that enhance cognitive skills through repeated engagement in targeted mental tasks (Rabipour & Raz, 2012). Cognitive flexibility is the brain's capacity for adaption to tasks, and the appropriate allocation of cognitive resources based on task demands (Atkins et al., 2011). Cognitive training may increase both cognitive flexibility and cognitive resources. Specifically, a goal of cognitive training is the generalization of cognitive processes, or the ability to utilize the same set of cognitive skills for different tasks (p. 224). For example, increasing working memory capacity through cognitive training may later transfer to enhanced comprehension in reading or to improved performance on multi-step mathematics operations.

Prior research indicates that cognitive training that addresses multiple cognitive functions including working memory, attention, and processing speed leads to improved academic performance for students (Jedlicka, 2012), and to enhanced attention and memory for the elderly and traumatic brain injury survivors (Schmiedek, Lovden, & Lindenberger, 2010; Westerberg et al., 2007). Research on cognitive training using both computer-based and face-to-face training formats for students with ADHD revealed a reduction in learners' inattention and hyperactivity (Van der Oord et al., 2012), enhancement of information retrieval from long-term memory (Carpenter, 2009; Gibson,

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2011), reduction in attention difficulties (Rabiner, Murray, Skinner, & Malone, 2010; Steiner et al, 2011), improvement in reading comprehension and passage copying (Shalev, Tsal, & Mevorach, 2007), improvement in working memory (Beck, Hanson, & Puffenberger, 2010), and increase in attention skill (Gibson, 2009).

The current study focused on the use of a one-on-one cognitive training program used by a network of cognitive training centers across the country. A series of studies has been conducted on how a one-on-one cognitive training program improves students' attention, processing speed, visual and auditory processing, logic and reasoning, oppositional behavior, and academic performance (Carpenter, 2009; Jedlicka, 2012; Luckey, 2009; Luckey, 2006; Pfister, 2013). In one such study, Jedlicka (2012) used a quasi-experimental design to compare outcomes from three student groups: a 12-week cognitive training program ($n = 77$), a 24-week cognitive training program ($n = 69$), and a control group ($n = 80$). Although no behavioral improvements were noted, participants in both treatment groups showed statistically significant improvements on measures of attention, processing speed, auditory and visual processing, logic and reasoning, sensory motor skills, school performance, and academic performance. No improvements were noted in the control group. Similarly, Pfister (2013) conducted a quasi-experimental, pretest-posttest study with adolescents ($n = 1,277$) who showed statistically significant gains in working memory and processing speed after 12 weeks of one-on-one cognitive training. Further, Luckey (2009) reported that after completing a one-on-one cognitive training intervention, participants ($n = 975$) across three groups (ADHD, dyslexia, no learning disability) realized statistically significant gains in general intelligence, working

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memory, and sound awareness. In a separate study, Luckey (2006) also found significant gains on auditory processing, processing speed, memory, visual processing, and logic and reasoning among students completing the same one-on-one program. Finally, Carpenter (2009) reported in a quasi-experimental, matched-control group study that participants (n = 30) who completed 24 weeks of one-on-one cognitive training achieved statistically significant gains in logic and reasoning, short-term memory, word attack, phonemic awareness, and long-term memory while the control group (n = 31) did not. These findings supported the current study's assumption that cognitive training is indeed a promising intervention for the remediation of cognitive skills deficits while illustrating the need to examine the factors in which cognitive training is most effective.

Instructor Personality and Student Achievement

This part of the literature review discusses research findings on the association between instructor personality and student achievement. The use of personality assessment tools in research is not aligned with the primary tenets of social cognitive theory. Instead, Bandura (1999) suggests that personality is dynamically situated within contexts—that the same behavior is different across situations and cannot be predicted by a static trait. However, the assessment of personality hinges upon the ability to describe complex traits using a few adjectives. Through factor analysis, personality psychologists have grouped traits based on correlations with several broad factors. Although Bandura (1999) refers to trait theory of personality as "socially disembodied reclusive personality" (p. 21), the five-factor model has widespread acceptance as the most validated personality

model across cultures (McCrea & Costa, 2013). It is defined by five primary personality factors: openness, conscientiousness, extroversion, agreeableness, and neuroticism. McCrea and Costa expressly contend that the model does not explain how the traits themselves function as aspects of individuals, but that is does provide a method for organizing research findings. Therefore, a focus on trait theory was necessary for this aspect of the current study in order to provide a quantifiable measure of personality for the analysis, and to review related research.

Education research indicates that a positive learning environment is a key contributor to student achievement. For example, teachers who are flexible, patient, and empathetic are positioned to connect with students through rapport and positive relationships (Rief, 2006). Prior research found associations between instructor characteristics and student achievement in multiple learning environments including general education classrooms (Garcia, Kupczynski, & Holland, 2011; Kneipp, Kelly, Biscoe, & Richard, 2010), special education classrooms (Carlson, Lee, & Schroll-Westat, 2004; Edmonds, 2010), tutoring programs (Putra, 2013), corporate training (Ghosh, Satyawadi, Joshi, Ranjan, & Singh, 2012), corporate coaching (de Haan, Culpin, & Curd, 2011; de Haan, Duckworth, Birch, & Jones, 2013), and mental health clinics (Charlebois, Vitaro, Normandeau, Brendgen, & Rondeau, 2004; Siqueland et al., 2000).

Several studies with high school and college student participants have revealed this relationship. For example, one study suggested that teachers' ($n = 32$) personality traits are a significant predictor of academic achievement for high school students (Garcia, Kupczynski, & Holland, 2011). Using Analysis of Variance (ANOVA) on 10th

graders' scores from two consecutive years on the Texas Assessment of Knowledge and Skills (TAKS), Garcia et al. discovered the teacher personality trait of "conscientiousness" accounted for 87% of the variance in student scores on language arts assessments, 97% of the variance in student scores on science assessments, and 92% of the variance in student scores on social studies assessments (p. 4). In another study, college instructor ($n = 63$) personality trait was a significant predictor of student perception of instructional quality (Kneipp, Kelly, Biscoe, & Richard, 2010). Multiple regression analysis was performed using archived teacher evaluation forms and the results of the instructors' Big Five Personality Inventory. Results revealed that the highest instructional quality ratings were best predicted for instructors with the personality trait of "agreeableness". That is, agreeableness was the only statistically significant predictor of instructional quality.

Tahir and Shah (2012) conducted a correlational study on the achievement of 663 psychology students and their instructor personality traits based on the Big Five Personality Inventory. The highest positive correlation reported was between academic achievement and the instructor personality trait "extroversion", followed by the personality trait "agreeableness". The only negative correlation reported was between academic achievement and the instructor personality trait "neuroticism".

Fenderson (2011) examined the personality traits of 2009 National Teacher of the Year candidates ($n = 17$) with the Five Factor Inventory, finding high scores on extroversion, conscientiousness, and agreeableness. These traits were consistent across teachers assigned to elementary and secondary grade levels, and across number of years

of teaching experience. Although no student data was collected for the study, effective teaching was operationalized by Teacher of the Year candidacy.

Research on personality traits across instructional settings is dominated by the use of the five-factor model and the Big 5 Personality Inventory (McCrea & Costa, 2013). However, several studies have also reported findings from the use of the Myers-Briggs Type Indicator (Myers & McCaulley, 1985). The Myers-Briggs Type Indicator (MBTI) measures four personality dimensions associated with how individuals prefer orienting to the world (extroversion or introversion), interpreting information (sensing or intuiting), making decisions (thinking or feeling), and interacting with the world (judging or perceiving). In a study of Myers-Briggs personality trait trends among the League of Teachers in Florida ($n = 58$), the dominant personality type that emerged was ENFP, referring to the combination of extroversion, intuition, feeling, and perceiving traits (Rushton, Morgan, & Richard, 2007). No student data was collected for the study. However, teachers selected for membership in the Florida League of Teachers have a record of superior student performance which characterized them as effective teachers to be recruited for the study.

In a correlation study examining the relationship between MBTI types and teaching efficacy among 72 student teachers, two personality dimensions had small but statistically significant correlations with teaching efficacy (Roberts, Mowen, Edgar, Harlin, & Briers, 2007). The personality trait of "sensing" had a small negative correlation ($r = -.25$) with efficacy for instructional strategies, and the personality trait of "judging" had a small positive correlation with efficacy for classroom management.

Similar to the previously reviewed studies conducted by Fenderson (2011) and Rushton, Morgan, & Richard (2007), student measures were not collect for the study.

Qualitative research findings have also contributed to teacher personality and student achievement literature. Colker (2008) interviewed 43 early childhood mentor teachers and administrators, asking questions to determine teacher characteristics needed for effective instruction. Thematic analysis revealed 12 characteristics, including

- passion,

- perseverance,

- a willingness to take risks,

- pragmatism,

- patience,

- flexibility,

- respect,

- creativity,

- authenticity,

- a love of learning, and

- a high level of energy.

In another qualitative study using interviews with special education teachers ($n = 24$), researchers identified three personality characteristics associated with accomplished teachers: reflectiveness, resourcefulness, and relentlessness (Bishop, Brownell, Klinger, Leko, & Galman, 2010).

Instructor personality has also been examined in the context of corporate training

environments. In one study, multiple regression analysis was performed using employee

($n = 80$) post-training evaluations as an outcome measure of instructional quality (Ghosh,

Satyawadi, Joshi, Ranjan, & Singh, 2012). The characteristics of corporate trainers that

were statistically significant predictors of instructional quality were strong interpersonal

skills (rapport with trainees) and subject matter expertise. In another study, Khair (2013)

also utilized multiple regression to assess training characteristics that predicted training

quality. An analysis of 118 employee surveys indicated that trainer characteristics (good

speaker, good listener, knowledgeable) were one set of five statistically significant

predictors of training quality.

Related research, on corporate coaching, reveals that specific coaching

interventions are less correlated with client ratings than are relationships with an

empathetic coach (de Haan, Culpin, & Curd, 2011). In a later study, de Haan et al.

(2013) examined 156 client-coach pairs and the factors of coaches that are associated

with effective coaching outcomes. The analysis revealed that although personality-

matching of coach and client were not mediating factors, the working relationship

between coach and client did predict coaching effectiveness.

Research on characteristics of mental health counselors also reveals the important

role of personality in instructional relationships. In a longitudinal study of participant

retention in a program for disruptive boys, researchers studied the association between

trainer ($n = 8$) behaviors and participant ($n = 58$) persistence in the program (Charlebois,

Vitaro, Normandeau, Brengen, & Rondeau, 2004). Linear regression analysis indicated

that the only statistically significant predictor of program persistence was proximal, one-

on-one contact with the trainer. For the study, the number of observed contacts—defined as each one-on-one interaction between trainer and participant—was the operationalized indicator of trainer focus on interpersonal relationships.

The impact of instructor personality traits on student achievement across learning environments has been illustrated by these studies. Indeed, the personality literature is rich with examples in education, training, and therapeutic settings. The current study was a natural extension of the prior research into the cognitive training environment.

Instructor Education and Experience and Student Achievement

This part of the literature review describes the research related to instructor degree field, degree level, type of experience, amount of experience, and certification. Although intuitively logical that an instructor's education and experience would impact student outcomes, the literature on the predictive value of instructor education and experience on student achievement is varied. The evidence for associating the education and experience of instructors with student achievement is difficult to examine, particularly in study designs using aggregated rather than student-level data. However, Munoz and Chang (2007) conducted a longitudinal study on student-level outcomes to predict achievement based on teacher education level, experience, and race. In their analysis of results for 58 teachers and 4,684 students, they found no statistically significant associations among the predictor and outcome variables. In an earlier study with prekindergarten students ($n = 939$), researchers did find significant associations between teacher education level and mathematics achievement (Early et al., 2006). In

that study, students with teachers holding a bachelor's degree or higher achieved greater gains than students with teachers holding a lower degree. However, teachers' college major and state certification were not predictors of academic outcomes in this study sample.

Edmonds (2010) did not find an association between teacher coursework or certification and student achievement either. In his study of 55 special education teachers and their 462 students, linear mixed modeling analysis revealed that only competitiveness of the undergraduate institution attended by the teacher had a significant effect on student outcomes. There were different outcomes in a study of mathematics achievement of students ($n = 3,786$) in 12th grades (Goldhaber & Brewer, 2000) in which those with teachers holding a degree and standard certification in math earned statistically significant higher math scores than students with teachers holding degrees in other fields; and science students ($n = 2,524$) with a teacher holding a degree and standard certification in science earned higher—but not significantly higher—science scores than students with teachers holding degrees in other fields.

Huang and Moon (2009) examined the relationship between teacher characteristics and second grade student achievement outcomes. Using hierarchical linear modeling to analyze the data of 1,544 students and 154 teachers, the researchers found no statistically significant associations between student achievement and teacher certification, education level, reading conference attendance, and total years of teaching experience. However, they did find a significant association between second grade achievement and teachers with more than five years of experience teaching second

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grade—suggesting that specific experience is a greater predictor than overall experience.

In a study of student data ($n = 23,000$) from the Early Childhood Longitudinal Study, researchers found a modest association between teachers' college degree field and first grade student reading achievement (Croninger, Rice, Rathbun, & Nishio, 2007). Students of teachers with elementary education degrees earned higher reading scores than students of teachers with other degrees; and students taught by teachers with less than two years of teaching experience achieved lower reading scores than students taught by teachers with more than two but less than five years of experience. This finding suggests that the benefit of teacher experience on student achievement is greatest between the second and fifth year of teaching.

In a factor analytic study of characteristics of effective special education teachers ($n = 7,668$), Carlson, Lee, and Schroll (2004) conducted computerized phone surveys to collect data on teacher credentials, experience, self-efficacy, professional activities, and classroom practices. They discovered high factor loadings for all five factors, particularly on total number of years teaching, number of years teaching special education, and certification in a field matching the teacher's placement.

Instructor experience is also a contributor to student outcomes in learning environments outside of the classroom. According to the results of Putra's (2013) dissertation study on face-to-face tutoring for teacher trainees, students who have tutors with advanced degrees achieve higher test scores than students with tutors holding bachelor's degrees. Also, in a study of therapist characteristics on training effects, experience level of cognitive therapists ($n = 19$) was found to positively correlate with

therapeutic effectiveness (Siqueland et al., 2000). Although both studies indicated an association between instructor experience and student and client outcomes, it was clear that additional research was needed to examine that relationship in other non-traditional learning environments.

Cognitive Skill of Instructors and Student Achievement

The final variable for which a review of the existing literature was conducted is that of the pre-hire cognitive test performance of instructors in relation to student achievement. For the current study, the participant test score was from a pre-employment speeded task designed to measure processing speed along with visual processing and attention. According to the American Management Association, 20% of employers use cognitive ability testing as part of their pre-employment protocol; and 50% of Fortune 1000 companies conduct pre-employment abilities testing (Piotrowski & Armstrong, 2006). A large body of research indicates that general tests of cognitive ability are strong and consistent predictors of work performance (Kuncel & Hezlett, 2010), perhaps due to their capability of forecasting the ability to continue acquiring the knowledge and skills needed for superior job performance (Ones, Viswesvaran, & Dilchert, 2005). In short, cognitive ability leads to rapid learning and use of job-related skills.

However, specific aptitude theory suggests that individual measures of cognitive skills should be included in any regression analysis of general mental ability and job performance; that is, the individual contribution of a cognitive skill that directly corresponds with a skill needed in the performance of a job should be assessed (Brown,

Le, & Schmidt, 2006). For example, because some jobs do not require high levels of general mental ability—but may require high levels of speed and accuracy—specific aptitude theory provides support for testing abilities of mental speed rather than abilities of mental power. In a study of 133 food distribution warehouse workers, measures of processing speed predicted job performance 15% better than measures of general mental ability (Mount, Oh, & Burns, 2008). In fact, prior research suggests that general mental ability declines in predictive validity as job complexity declines, but that processing speed has the highest predictive validity of job performance across samples and cognitive skills tested (Bertua, Anderson, & Salgado, 2005).

However, results from a large study of military trainees ($n = 26,097$) enrolled in 10 different career training programs revealed no significant difference in the predictive validity of training performance from individual skill tests and tests of general mental ability (Brown, Le, & Schmidt, 2006). Further, a large non-experimental study of archived records on the relationship between the cognitive ability of 704 teachers and the achievement outcomes of 24,847 students in Sweden also indicated no statistically significant relationship between the those variables (Gronqvist & Vlachos, 2008). This finding aligns with Darling-Hammond's (2000) comprehensive analysis of the teacher quality-student achievement link that found a only small relationship with verbal ability while finding that the remaining measures of teacher intelligence were not significant predictors of student achievement.

The practice of requiring a pre-employment evaluation of a job-related skill such as processing speed is illustrated most commonly in the typing certificate required for

many clerical positions. Despite the long history of this practice, there is a glaring absence of research on the validity of its use. Further, an exhaustive search of the extant research on the association between work performance and individual cognitive skills—including processing speed—did not reveal how this variable impacts student outcomes. The variable was included in the current study because cognitive trainers in the study sample represent a population of cognitive trainers who must pass a cognitive screening task measuring as part of their pre-hire interview process. This unique but under-researched practice supported the need to investigate the usefulness of assessing cognitive trainer processing speed in predicting future performance with students.

Synthesis of the Research Findings

Prior research indicates that attention deficit hyperactivity disorder (ADHD) is characterized by a deficit in executive functioning. Not only do individuals with ADHD have an impaired system for coordinating and regulating multiple cognitive processes (Brown, 2006), they also struggle with deficits in individual cognitive skills such as attention, memory, and speed of information processing (Martel et al. 2006; Martinussen et al., 2005; McQuade et al., 2011). The cognitive deficits inherent with ADHD can impact social, academic, and occupational functioning (APA, 2013). Research reveals that cognitive training is a promising intervention for remediating cognitive skill deficits by increasing cognitive flexibility, cognitive resources, and the generalization of cognitive processes (Atkins et al., 2011; Rabipour & Raz, 2012). Studies have revealed improvements in academic functioning (Jedlicka, 2012), as well as improvements in

intelligence, memory, and processing speed (Pfister, 2013; Luckey, 2009). Because cognitive training is delivered one-on-one by cognitive trainers, this unique learning environment was rich with opportunity to examine associations between cognitive trainer characteristics and outcomes for students with ADHD.

 A review of the current research related to instructor characteristics and student achievement revealed several trends. The research that links instructor personality to student achievement aligns with the theoretical interpretation of personality traits as relational constructs to be measured in terms of interpersonal dimensions rather than stand-alone characteristics (Wiggins & Trapnell, 1996). That is, characterization of personality is always dependent upon how an individual relates to others. This is evident in the literature that indicates teacher "agreeableness" is associated with instructional quality (Kneipp et al. 2010); and teacher "extroversion" is associated with the highest student achievement outcomes (Rushton et al., 2007; Tahir & Shah, 2012). Indeed, these findings point to an interesting teacher-student relational dynamic that influences student performance.

The research on the association of instructor education and experience with student outcomes is not as clear. One trend in the research shows that teacher education and experience specific to courses taught is a greater predictor of student achievement than overall experience. Notably, these associations were significant for teaching math and science (Goldhaber & Brewer, 2000), and for teaching second grade (Huang & Moon, 2009). The only other remarkable finding in the literature was that the greatest student achievement outcomes were noted for students with teachers who had between

two and five years of teaching experience. Student gains leveled off after the teacher's fifth year (Croninger et al., 2007). Outside of the classroom, however, instructor education level and experience did have a significant association with student outcomes (Putra, 2013; Siqueland et al., 2000). It is unclear why the impact was greater in non-traditional education settings, but further research was therefore warranted.

The research related to pre-employment cognitive testing is skeletal in the instructional setting. Although research does support the strength of general cognitive testing as a predictor of job performance (Kuncel & Hezlett, 2010; Ones, Viswesvaran, & Dilchert, 2005), and has identified processing speed as a key contributor to job performance (Bertua, Anderson, & Salgado, 2005), only one related study focused on student outcomes. However, the study did not reveal significant associations among cognitive skills of teachers and the achievement of their students (Gronqvist & Vlachos, 2008). Further, participants scored at or above the minimum threshold, so it is not known how low cognitive scores would have impacted student outcomes. Thus, it remains unclear whether instructor processing speed is indeed a predictor of student achievement.

There are clear methodological trends in the existing literature as well. Three studies that examined associations between instructor personality and student achievement utilized non-experimental, correlational study designs analyzed with Pearson's *r* or linear regression. This is not surprising, however, due to the nature of the variables. Instructor personality traits are pre-existing and are not variables appropriate for experimental manipulation. Instead, the classroom studies in this topic area utilized existing student test scores (Garcia et al., 2011), student grades (Tahir & Shah, 2012),

student evaluations of instructors (Kneipp et al., 2010), and award-winning teacher status (Fenderson, 2001; Rushton et al., 2007) as outcome measures; and Big 5 Personality Inventory or MBTI results as predictor variables. The sample sizes ranged from 32 to 663, and included teachers, student teachers, and students in American elementary school, high school, and college settings.

Studies reviewed on the association between instructor personality and student achievement in corporate training settings were also dominated by non-experimental designs using linear regression analysis. Although a personality inventory was not used, all three studies regressed employee survey reports of instructor characteristics on ratings of instructional quality (de Haan et al., 2013; Ghosh et al., 2012; Khair, 2013). Sample sizes ranged from 80 to 156, including executive coaches and clients in the United Kingdom, customer service trainers and employees in Pakistan, and trainers and employees from the energy and power industry in India. Instruments included a modified version of the Working Alliance Inventory, and two researcher-developed surveys.

Finally, a qualitative interview study design was used for two studies to examine the personality characteristics of effective teachers. The sample sizes for the interviews of American education administrators and mentor teachers were $n = 43$ (Colker, 2008) and $n = 24$ (Bishop et al., 2010). Student outcome measures were not collected.

Similar methodological trends were noted in the literature examining the association of instructor education and experience and student achievement. Six of the seven school-based studies utilized non-experimental designs with analysis of archived student data using standardized test scores as the outcome variable. Teacher surveys

were used to collect education and experience data in one of the studies. Samples included 154 second grade teachers in Virginia high-poverty schools (Huang & Moon, 2009), 2,098 high school math teachers and 1,371 high school science teachers from nationally-representative schools across America (Goldhaber & Brewer, 2000), 237 pre-kindergarten teachers in six states (Early et al., 2006), 58 high school reading teachers in Kentucky (Munoz & Chang, 2007), 55 special education teachers in Ohio (Edmonds, 2010), and 1,352 kindergarten teachers across America (Croninger et al., 2005). Five of the studies analyzed the data using advanced regression procedures including multi-level modeling and linear mixed modeling. One study relied on analysis of covariance (ANCOVA), and the seventh study conducted factor analysis on teacher practices without direct association to student outcomes (Carlson et al., 2004).

Two studies on instructor education and experience outside of the classroom setting utilized slightly different designs. Siqueland et al (2000) examined the impact of therapist training on therapeutic effectiveness with three groups of therapists in Pennsylvania ($n = 62$). They did not use an experimental design but, instead, correlated the therapy outcomes with therapist training and education within each group. The second study used a mixed methods design with observations, interviews, and student final exam scores to correlate tutor characteristics with student achievement (Putra, 2013). The sample for the study included 72 tutors in an Indonesian university's teacher education program.

The methodologies employed for three studies reviewed on the association between pre-hire cognitive testing and student or employee achievement were non-

experimental studies using linear regression analysis. Sample sizes ranged from 133 to 26,097 including food distribution warehouse workers in the American Midwest (Mount, Oh, & Burns, 2008), predominately-male military trainees in Naval technical schools (Brown, Le, & Schmidt, 2006), and 9th grade teachers in Sweden (Gronqvist & Vlachos, 2008). Predictor variables as measures of cognitive skills included the Swedish military cognitive draft evaluation, general mental ability measured by subtests on the Armed Services Vocational Aptitude Battery, and the Wonderlic Personnel Test. Outcome measures included military training performance, student standardized test scores, and work performance evaluations.

Overall, nearly every study reviewed on the association between instructor characteristics and student achievement utilized non-experimental correlational designs or prediction designs with multiple regression analysis on archived data. Because instructor characteristics are not variables that are appropriate for experimental manipulation—because they are either innate (personality traits) or previously established (education and experience)—the non-experimental design matched the purposes of each of the studies. Therefore, the current study's non-experimental design using multiple regression analysis to predict trainer characteristics associated with student outcomes is indeed aligned with the methodological trends in the literature.

Critique of the Previous Research

There are notable gaps in the previous research on instructor characteristics associated with student achievement. No research had been conducted on the non-

treatment related variables associated with cognitive training. As Jaeggi et al. (2011) suggested in their examination of cognitive training benefits, the conditions in which cognitive training is most effective had not been investigated. It was still unknown if cognitive trainer characteristics are related to cognitive training outcomes for students. The current study sought to address this gap in the literature.

Although there is a rich literature base on cognitive deficits associated with ADHD (Martel et al. 2006; Martinussen et al., 2005; McQuade et al., 2011), a challenge with measuring cognitive skill deficits is the confounding of constructs, or overlapping of cognitive skills. For example, attention is a pre-requisite for memory. If one cannot attend to a topic, one cannot bank the topic in memory. Therefore, prior research explicating specific skill deficits among individuals with ADHD is limited by the overlap of other cognitive skills which may or may not also be deficient. Researchers may struggle to accurately isolate specific skill deficits associated with the disorder. However, this is an inherent challenge with all cognitive psychology measurement research and was certainly beyond the scope of this study to address. This concern may have been mitigated in the current study's measures of working memory, long-term memory, and processing speed from the Woodcock Johnson III – Tests of Cognitive Abilities due to its strong construct validity (Woodcock, McGrew, & Mather, 2007).

Although the methodological trend of non-experimental studies identified in the instructor characteristics and student achievement literature is arguably an appropriate one, the glaring methodological gap in the literature specifically on cognitive training, particularly for students with ADHD, is the dearth of experimental, randomized control

group studies. The prior research on one-on-one cognitive training has been conducted with self-selected participants in a tuition-based cognitive training program. The control groups in the studies (Carpenter, 2009; Jedlicka, 2012; Luckey, 2009; Pfister, 2013) were selected based on parental decision (after pre-testing) to not enroll the student in the cognitive training program due to cost or time constraints—another form of self-selection rather than investigator assignment. Selection bias is a potential threat to the internal validity of these studies (Shadish, Cook, & Campbell, 2002). However, there are ethical considerations when designing an intervention efficacy study with children; that is, children with academic difficulties need timely remediation. Assigning students to a 24-week placebo intervention precludes a timely remediation of the skills necessary for learning. Therefore, the quasi-experimental design of these prior studies may certainly be justifiable. Although the current study was not examining the efficacy of cognitive training, the critique is relevant to the study's assumption that cognitive training is indeed an effective intervention for students with ADHD.

Summary

No research on cognitive training had been conducted to examine how cognitive trainer characteristics are associated with student gains in working memory, long-term memory, processing speed, and general intelligence. Although not consistent in findings, prior research on the association of instructor characteristics – including personality, education, and experience—and student achievement provided strong support for the investigation of this association in the cognitive training environment. Trends in the literature suggested strong evidence for an association between instructor personality characteristics and student achievement, and moderate evidence for an association with instructor experience and education and student achievement. Given the theoretical support for relationships as moderators to learning and the development of self-efficacy for learning (Bandura, 1997; Schunk & Miller, 2002), this relationship should indeed have been examined in the context of cognitive training. Therefore, the current study aimed to fill the gap in the cognitive training literature by examining trainer characteristics that predicted outcomes for students with and without ADHD; and also added to the literature on the relationship between instructor characteristics and student outcomes by examining that relationship in the cognitive training setting.

CHAPTER 3. METHODOLOGY

Purpose of the Study

The purpose of the current study was to investigate the characteristics of cognitive

trainers that predicted cognitive training outcomes for students with and without ADHD.

Although research had demonstrated support for the efficacy of cognitive training

programs (Gibson, 2009; Holmes et al., 2009 ; Klingberg et al., 2005; Melby-Lervag &

Hulme, 2013; Sonuga-Barke et al., 2013; Wegrzyn, Hearrington, Martin, & Randolph,

2012), no studies had identified the factors unrelated to treatment tasks that predict

cognitive training gains. Further, no studies had examined how the characteristics of

cognitive trainers predicted training outcomes. Knowledge of the predictive value of

these trainer characteristics (including college degree and level, cognitive training

certification level, personality traits, and pre-hire cognitive test scores) may assist

program administrators in maximizing the benefits of the training for students with

ADHD through appropriate matching of trainer and student. Because over 33% of

students enrolled in one-on-one cognitive training programs in 2011 had been previously

diagnosed with ADHD; and 67% of students reported problems with attention prior to

enrollment (Gibson, 2011), it was valuable to examine the association of cognitive trainer

traits with learning outcomes of students with and without ADHD.

Research Design

The study employed a non-experimental, quantitative design with a multiple

regression analysis of archival and survey data to determine the predictive value of the

trainer characteristics (college major, degree level, certification level, personality traits, and pre-hire cognitive test score) on the outcome variables of general intelligence, working memory, long-term memory, and processing speed of students with ADHD and without ADHD. The dependent variables were obtained by using the pre-test and post-test measures of working memory, long-term memory, processing speed, and general intelligence on corresponding batteries from the Woodcock Johnson III – Tests of Cognitive Abilities. Difference scores between pretest and post-test were calculated by the researcher to be used as the dependent variables. The student pre and post-test data were provided by the corporate headquarters of a national network of cognitive training centers. The Big 5 personality inventory was used to profile participants' personality traits, and was administered online with a trainer survey to collect trainer degree, college major, trainer certification level, and pre-hire cognitive test score. Multiple regression analyses was used to find out which trainer characteristics predicted learning outcomes for all students with and without ADHD, followed by split file multiple regression analyses for students with ADHD and students without ADHD. Finally, a follow-up Fisher's z test was used to compare the R-squared values for each MR model, and to analyze the weights of each predictor variable in both groups.

Target Population and Participant Selection

The sample for the current study represented the greater population of cognitive trainers. Cognitive trainers are clinicians with diverse backgrounds that include education, psychology, speech therapy, occupational therapy, nursing, counseling, and

other allied fields who implement face-to-face cognitive training protocols to individuals with ADHD. The sample of participants were currently employed as cognitive trainers at a cognitive training center in the same proprietary network; or participated in the training of students as a job function. To be eligible for inclusion, trainers must have been currently employed and have had students who had already completed training. Demographic data of trainers was collected, but the recruitment was not stratified accordingly. The general sample size needed for this study was determined by the recommendations for multiple regression analysis as 20 times the number of variables (Warner, 2013). With four variables for the education and experience model for multiple regression analyses, and a fifth variable for the personality trait model for multiple regression analyses, the ideal sample size for this study was $n = 100$. For a more specific targeted sample size, a G*Power analysis was conducted with the following parameters: a medium effect size of .15, an alpha level of .05, a power of .80, and 5 predictor variables. The analysis yielded a required sample size of $n = 92$. The total population of eligible cognitive trainers was estimated to be $n = 1,620$. Therefore, only 6% of the eligible cognitive trainers were needed as the sample for the current study.

A purposive sampling strategy was followed for recruiting participants for the study. With the assistance of the corporate cognitive training headquarters, an email invitation written by the researcher was forwarded to all cognitive trainers in the national network of cognitive training centers. The invitation included a brief description of the study and a link to the Cognitive Trainer Questionnaire hosted on Survey Monkey. A copy of the questionnaire is located in Appendix A. Contact information of the

researcher was provided for interested participants to ask questions prior to giving consent. Interested participants visited the secure website, gave online informed consent, and completed the questionnaire and the Big 5 Personality Inventory items. Interest in the study was generated by the corporate headquarters by posting an announcement about the study on the internal program management system shared among all training centers in the network. Having this endorsement of the corporate leadership was thought to make trainers more comfortable about participating. To ensure maximum participation, a reminder email written by the researcher was forwarded by the corporate headquarters after two weeks.

Procedures

The data for the study was collected in three stages. First, student data was collected from the archived records at the corporate cognitive training headquarters. Then, trainer data was collected from participants in an online questionnaire with personality inventory. Finally, the datasets were linked prior to analysis.

Cognitive Trainer Data

After cognitive trainers received the email invitation to participate in the study, interested participants clicked through a link to the Cognitive Trainer Questionnaire on the secure survey site, Survey Monkey. They provided their name, education level, degree field for undergraduate and graduate degrees, trainer certification level, and their time score from a proprietary pre-hire cognitive screening task designed to measure

visual processing, processing speed, working memory, and attention. The range of possible scores was between 60 and 240 seconds.

The first part of the questionnaire included trainer education, employment, and demographic questions outlined below:

1. Please enter your first name and the first initial of your last name.

2. Please enter the name and location of the center where you are employed.

3. What is the highest level of education you have completed: bachelor's degree, master's degree, post-master's specialist, doctoral degree.

4. Please select the category that most closely matches your major field of study from your bachelor's degree: education, psychology/counseling, sociology/social work, occupational therapy, nursing/medical, other.

5. Please select your major field of study for your graduate degree, if applicable: n/a, education, psychology/counseling, sociology/social work, occupational therapy, nursing/medical, other.

6. Please select your trainer certification level: Basic Certification, Advanced Certification, Master Certification.

7. Please enter the month and year you began employment at your center.

8. Please enter your speed score from the [cognitive speed] screening you completed during your pre-employment interview.

9. Which category includes your age? 18-20, 21-29, 30-39, 40-49, 50-59, 60+

10. What is your gender? Male, Female

11. What is your ethnicity? American Indian or Alaskan Native, Asian or Pacific

Islander, Black or African American, Hispanic or Latino, White/Caucasian, Prefer

not to answer, Other

The second half of the questionnaire was populated with the 44-items from the

Big 5 Personality Inventory, shown in Appendix A. Answers to the profile were scored

with IBM SPSS Version 22 using the publisher's coding.

Student Data

An Excel spreadsheet with student scores was provided to the researcher by the

corporate cognitive training headquarters. Using the names of the participants, the

researcher filtered the existing archived student data for students who had completed

cognitive training with a trainer participating in the current study. Prior to initiating

cognitive training, students were assigned to a trainer based on schedule availability.

Test results were not a factor in student placement. Student data from trainers not

participating in the study were deleted from the dataset. Using the filtered dataset, the

researcher replaced student ID numbers with random case numbers generated to protect

confidentiality and anonymity for this study. The case numbers were used solely for the

purpose of the current study and did not include any identifiable information. The

original student ID numbers and corresponding case numbers were stored in a password

protected file on the researcher's password protected laptop in her home office to be used

only if data became corrupted and needed to be restored for analysis.

Linked Datasets

Finally, the student and trainer datasets were linked, and trainer names were replaced by randomly generated case numbers to be used only for this study. This process protected the anonymity for both trainers and students. A copy of the original file was saved in a password-protected folder on the researcher's password protected laptop. The final dataset was projected to include approximately 100 participants linked to a minimum of 300 student records. In SPSS, the trainer codes were assigned as a student variable. Each row of student data included case number, gender, age, race, cognitive test scores, trainer code, and trainer questionnaire results.

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Instruments

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Big 5 Personality Inventory

In the current study, the 44-item Big Five Inventory (John, Naumann, & Soto, 2008; John, Donahue, & Kentle, 1991) was used to measure the predictor variable *personality trait*. Internal consistency reliability of the Big Five Inventory was conducted using a sample of $n = 829$ undergraduates; and ranged from .79 to .87 across the five traits with a mean of .83 (John & Soto, 2007). Convergent validity across other measures of the Big Five traits was even stronger, with a mean of .95. Blanket permission to use the instrument for research only was granted by Oliver John of the Berkeley Personality Lab at University of California at Berkeley. Registration of the current study was required. The inventory was given to participants in a computer-based format, accessed

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through the Survey Monkey website.

The Big 5 Inventory consists of five construct scales (extraversion, agreeableness, conscientiousness, neuroticism, and openness) with 8 to 10 items per scale measured on a range from 1 to 5. The scores are averaged to produce scale scores. For the current study and consistent with prior Big 5 Inventory research (Srivastava, John, Gosling, & Potter, 2003), scale scores were converted to percentage of maximum possible (POMP) scores, a linear transformation of scores to a 0-100 scale used when scale ranges are limited. The five construct scores were used as five levels of the personality trait predictor variable.

Woodcock-Johnson III Tests of Cognitive Abilities

The data collection instrument for the current study was the Woodcock-Johnson III Tests of Cognitive Abilities (Woodcock, McGrew, & Mather, 2007). The dependent variable measures were calculated difference scores between pretest and post-test standard scores. Because the student data was archival, this instrument had already been used by the cognitive trainers to collect pretest and post-test data that were analyzed for the study. The Woodcock-Johnson III (WJ III) collects measures of aggregate general intelligence; and individual measures of cognitive skills including logic and reasoning, processing speed, auditory processing, visual processing, long-term memory, and working memory. It has been normed on 8,818 participants, including 4,783 students in Kindergarten through 12th grade. Confirmatory factor analyses validated the correlation between the WJ III and the Cattell-Horn-Carroll (CHC) theory of cognitive abilities as a measure of validity; that is, the test closely measures general intelligence as well as the

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eight cognitive sub-skills identified in the CHC theory. Validity coefficients for the three cognitive skills measured in the current study are working memory (.71), long-term memory (.80), and processing speed (.71).   Internal consistency reliability ranges from .80 to .90 for individual tests and over .90 for each cluster (Cizek, 2012).

The data collected included standard scores for each of the three construct scales (long-term memory, working memory, and processing speed) and a general intellectual ability (GIA IQ) score on a standard scale ($M = 100$, $SD = 15$). The scores are generated by preprogrammed software algorithms based on raw data input by cognitive trainers.

Research Questions and Hypotheses

Primary Research Question

Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in general intelligence, working memory, long-term memory, and processing speed for students with and without ADHD?

Research Question 1

Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *general intelligence* for students with and without ADHD?

Null hypothesis. There is no significant correlation among variables. All of the

coefficients are zero and none of the variables significantly predicts general intelligence gains in the program: H_0: $\beta_1 = \beta_2 = ... = \beta_5 = 0$

Research Hypothesis 1.1. Trainer personality type is a significant predictor of general intelligence gains from the program: H_1: $\beta_1 \neq 0$

Research Hypothesis 1.2. Trainer educational level is a significant predictor of general intelligence gains from the program: H_2: $\beta_2 \neq 0$

Research Hypothesis 1.3. Trainer certification level is a significant predictor of general intelligence gains from the program: H_3: $\beta_3 \neq 0$

Research Hypothesis 1.4. Trainer pre-hire cognitive test score is a significant predictor of general intelligence gains from the program: H_4: $\beta_4 \neq 0$

Research Hypothesis 1.5. Trainer degree field is a significant predictor of general intelligence gains from the program: H_5: $\beta_5 \neq 0$

Research Question 2

Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *working memory* for students with and without ADHD?

Null hypothesis. There is no significant correlation among variables. All of the coefficients are zero and none of the variables significantly predicts working memory gains in the program: H_0: $\beta_1 = \beta_2 = ... = \beta_5 = 0$

Research Hypothesis 2.1. Trainer personality type is a significant predictor of working memory gains from the program: H_1: $\beta_1 \neq 0$

Research Hypothesis 2.2. Trainer educational level is a significant predictor of working memory gains from the program: H_2: $\beta_2 \neq 0$

Research Hypothesis 2.3. Trainer certification level is a significant predictor of working memory gains from the program: H_3: $\beta_3 \neq 0$

Research Hypothesis 2.4. Trainer pre-hire cognitive test score is a significant predictor of working memory gains from the program: H_4: $\beta_4 \neq 0$

Research Hypothesis 2.5. Trainer degree field is a significant predictor of working memory gains from the program: H_5: $\beta_5 \neq 0$

Research Question 3

Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *long-term memory* for students with and without ADHD?

Null hypothesis. There is no significant correlation among variables. All of the coefficients are zero and none of the variables significantly predicts long term memory gains in the program: H_0: $\beta_1 = \beta_2 = ... = \beta_5 = 0$

Research Hypothesis 3.1. Trainer personality type is a significant predictor of long term memory gains from the program: H_1: $\beta_1 \neq 0$

Research Hypothesis 3.2. Trainer educational level is a significant predictor of long term memory gains from the program: H_2: $\beta_2 \neq 0$

Research Hypothesis 3.3. Trainer certification level is a significant predictor of long term memory gains from the program: H_3: $\beta_3 \neq 0$

Research Hypothesis 3.4. Trainer pre-hire cognitive test score is a significant predictor of long term memory gains from the program: $H_4: \beta_4 \neq 0$

Research Hypothesis 3.5. Trainer degree field is a significant predictor of long term memory gains from the program: $H_5: \beta_5 \neq 0$

Research Question 4

Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes processing speed for students with and without ADHD?

Null hypothesis. There is no significant correlation among variables. All of the coefficients are zero and none of the variables significantly predicts processing speed gains in the program: $H_0: \beta_1 = \beta_2 = ... = \beta_5 = 0$

Research Hypothesis 4.1. Trainer personality type is a significant predictor of processing speed gains from the program: $H_1: \beta_1 \neq 0$

Research Hypothesis 4.2. Trainer educational level is a significant predictor of processing speed gains from the program: $H_2: \beta_2 \neq 0$

Research Hypothesis 4.3. Trainer certification level is a significant predictor of processing speed gains from the program: $H_3: \beta_3 \neq 0$

Research Hypothesis 4.4. Trainer pre-hire cognitive test score is a significant predictor of processing speed gains from the program: $H_4: \beta_4 \neq 0$

Research Hypothesis 4.5. Trainer degree field is a significant predictor of processing speed gains from the program: $H_5: \beta_5 \neq 0$

Data Analysis

For each research question, there were five predictor variables and one outcome variable for analysis. Two predictor variables were on a ratio scale: pre-hire cognitive test score measured in seconds, and Big 5 Inventory scaled scores from 1 to 100. The remaining three predictor variables were dummy-coded dummy variables: college degree field (psychology, education, medicine, other), college degree level (less than bachelor's degree, bachelor's degree, master's degree, post-master's degree), and trainer certification (Basic Certification, Advanced Certification, Master Certification). Basic certification is the entry-level certification; advanced certification can be earned after 24 months of employment and completion of continuing education; master certification can be earned after 48 months of employment and completion of advanced continuing education. The interval-scale outcome variables were working memory, long-term memory, processing speed, and general intelligence (IQ) score measured as the difference in pretest and post-test standard scores.

To answer each research question, four standard multiple regression analyses were conducted with IBM SPSS 22 using two regression models. Multiple regression is a statistical procedure that enables the researcher to identify correlations among multiple predictive factors of a single outcome. The first regression model is referred to as the *education and experience model*, including four predictor variables: college degree field, degree level, trainer certification level, and pre-hire cognitive test score. The second model is referred to as the *personality trait model*, which includes the five levels of the personality trait predictor variable.

First, an *F* ratio omnibus test for overall significance of the education and
experience model was conducted as shown in *Equation 1*:

$$F = SS_{\text{regression}} / k \div SS_{\text{residual}} / (N - k - 1) \tag{1}$$

This test indicated if the variance in student gain scores could be predicted from this set
of four trainer characteristics. If the overall *F* ratio was significant at the .05 alpha level,
then tests to determine the significance of individual predictor variables were conducted.
The effect size was indicated by multiple *R* and R^2, which revealed the percentage of
variance accounted for by the model. The predictive value of each predictor variable was
obtained by the *t* ratio of each regression slope shown in *Equation 2*:

$$t = b_i \div SE_{bi} \tag{2}$$

The effect size index for the individual predictor variables was the squared part
correlation, or sr^2_{unique} (Warner, 2012). This effect size indicated what percent of
variance in student score was uniquely predicted by each variable.

Then, a split file multiple regression for students with ADHD and students
without ADHD was conducted for each research question using the same procedures.
The split-file method was selected over using ADHD/no ADHD as a categorical predictor
variable to align with the research questions which only ask about trainer characteristics
as predictor variables. A follow-up Fisher's *z* test was used to compare the *R*-squared

values for each MR model, and to analyze the weights of each predictor variable in both groups. The results of the Fisher's z test indicated whether there was a significant difference in the correlation coefficients between the model for students with ADHD and the model for students without ADHD. The same steps were then repeated for the analyses of the personality trait model. First, an F ratio omnibus test for overall significance of the personality trait model was conducted. If the overall F ratio was significant at the .05 alpha level, then tests to determine the significance of individual personality traits (5 levels of the predictor variable) followed. Then, a split file multiple regression for students with ADHD and students without ADHD was conducted for each research question using the same procedures. A follow-up Fisher's z test was used to compare the R-squared values of the model for students with ADHD and the model for students without ADHD. Statistics and data sources are outlined in Table 1.

Table 1. *Statistics for Research Questions*

Research Question	Source of Data (Variables)	Statistics
1. Do cognitive trainer characteristics of personality trait, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in general intelligence for students with and without ADHD?	Ratio scale variable: Big 5 Personality Inventory scores (Openness, Conscientiousness, Extroversion, Agreeableness, Neuroticism) Categorical variable: College Major (education, psychology, medical, other)	Multiple regression
	Table continues	

Table 1 (continued)

Research Question	Source of Data (Variables)	Statistics
	Categorical variable: Degree level (associates, bachelors, masters, Above masters)	
	Categorical variable: Certification Level (Basic, Advanced, Master)	
	Ratio scale variable: Speed in seconds on pre-hire cognitive test	
	Interval scale variable: Woodcock Johnson III GIA difference score	
	Ratio scale variable: Big 5 Personality Inventory scores (Openness, Conscientiousness, Extroversion, Agreeableness, Neuroticism)	
2. Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *working memory* for students with and without ADHD?	Categorical variable: College Major (education, psychology, medical, other)	Multiple Regression
	Categorical variable: Degree level (associates, bachelors, masters, Above masters)	
	Categorical variable: Certification Level (Basic, Advanced, Master)	
	Ratio scale variable: Speed in seconds on pre-hire cognitive test	
	Interval scale variable: Woodcock Johnson III working memory difference score	*Table continues*

Table 1 (continued)

Research Question	Source of Data (Variables)	Statistics
3. Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *long-term memory* for students with and without ADHD?	Ratio scale variable: Big 5 Personality Inventory scores (Openness, Conscientiousness, Extroversion, Agreeableness, Neuroticism) Categorical variable: College Major (education, psychology, medical, other) Categorical variable: Degree level (associates, bachelors, masters, Above masters) Categorical variable: Certification Level (Basic, Advanced, Master) Ratio scale variable: Speed in seconds on pre-hire cognitive test Interval scale variable: Woodcock Johnson III long term memory difference score	Multiple regression
4. Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes *processing speed* for students with and without ADHD?	Ratio scale variable: Big 5 Personality Inventory scores (Openness, Conscientiousness, Extroversion, Agreeableness, Neuroticism) Categorical variable: College Major (education, psychology, medical, other) Categorical variable: Degree level (associates, bachelors, masters, Above masters)	Multiple regression

Table continues

Table 1 (continued)

Research Question	Source of Data (Variables)	Statistics
	Categorical variable: Certification Level (Basic, Advanced, Master)	
	Ratio scale variable: Speed in seconds on pre-hire cognitive test	
	Interval scale variable: Woodcock Johnson III processing speed difference score	

Ethical Considerations

There were several ethical considerations relevant to this study. First, the use of a large archived student dataset required an organized system for assigning and safely storing case code numbers that corresponded to the original student and trainer ID numbers. Deliberate and methodical care was taken to ensure the datasets were correctly linked prior to analysis. Second, the researcher is employed as a research director of an institute founded by the CEO of the cognitive training center network used for this study. As such, the researcher has access to student data as required for the job, so she needed to follow different procedures for protecting anonymity of the data for the current study. She accomplished this by collecting the trainer data through Survey Monkey and linking the datasets using her home computer. The trainer data was never accessible to anyone other than the researcher.

Expected Findings

The expected finding from this study was that cognitive trainer personality traits would have significant predictive value on student training outcomes. Prior research had indicated that teacher personality style is a significant predictor of academic achievement, accounting for 87% of gain in language arts scores, 97% of variance in science scores, and 92% of variance in social studies scores in one study (Garcia, Kupczynski, & Holland, 2011). Further, there was theoretical support for relationships as moderators to learning and the development of self-efficacy for learning (Bandura, 1997; Schunk & Miller, 2002). Therefore, the variable of trainer personality score was hypothesized to predict student gains across all outcome variables in the current study: working memory, long-term memory, processing speed, and general intelligence.

CHAPTER 4. DATA COLLECTION AND ANALYSIS

Introduction

This chapter presents the results of data analyses conducted for the study, including detailed tables and narrative descriptions of each analysis. Each type of analysis is described with results organized by the individual research hypotheses. Collectively, the four hypotheses for the study were that cognitive trainer characteristics—including personality traits, degree level, degree field, certification level, and pre-hire cognitive test score—will predict cognitive training outcomes in long-term memory, working memory, processing speed, and general intelligence for students with and without ADHD.

Description of the Sample

The sample for the study represented the greater population of cognitive trainers—clinicians with diverse backgrounds that include education, psychology, speech therapy, occupational therapy, counseling, nursing, and other allied fields who implement face-to-face cognitive training protocols to individuals with ADHD. To be eligible for the study, cognitive trainers had to be currently employed at a cognitive training center and must have already completed training of students. That is, there had to be pretest and posttest student data available to link with participating trainers. Demographic data of trainers was collected, but the recruitment was not stratified accordingly.

The general sample size needed for this study was determined by the

recommendations for multiple regression analysis as 20 times the number of variables (Warner, 2013). With four variables for the education and experience multiple regression analyses, and a fifth variable for the personality trait multiple regression analyses, the ideal sample size for this study was $n = 100$. For a more specific targeted sample size, G*Power analysis was conducted with the following parameters: a medium effect size of .15, an alpha level of .05, a power of .80, and 5 predictor variables. The analysis yielded a required sample size of $n = 92$. Although 217 trainers volunteered to participate, participants without pretest and posttest student data were not included in the study. The total number of eligible participants for the study was $n = 150$, and the number of total associated student cases was $n = 1,195$.

A purposive sampling strategy was followed for recruiting participants. An email invitation written by the researcher was forwarded to cognitive trainers ($n = 1,620$) by the headquarters of a network of cognitive training centers. The invitation included a brief description of the study and a link to the Cognitive Trainer Questionnaire hosted on Survey Monkey. My contact information was provided for interested participants to ask questions prior to giving consent. Interested participants visited the secure website, gave online informed consent, and completed a demographic education and experience profile and Big 5 Personality Inventory. Interest in the study was generated by the corporate headquarters through posting an announcement about the study one week prior on the internal program management system shared among all training centers in the network. A follow-up email invitation was sent two weeks after the initial invitation.

Descriptive statistics for participants are presented in Table 2. The most common

degree level was bachelor's (71%), followed by master's (20%).

Table 2. *Demographic and Educational Characteristics of Trainers (n = 150)*

Variable	Number	Percentage
Trainer Degree		
Less than Bachelor's	7	4.70%
Bachelor's	107	71.30%
Master's	30	20.00%
Post-Master's	6	4.00%
Trainer Degree Field		
Psychology	48	32.00%
Education	42	28.00%
Medical/OT/SLP	19	12.70%
Other	41	27.30%
Trainer Certification		
Basic Certification	59	39.30%
Advanced Certification	41	27.30%
Master Certification	50	33.30%
Trainer Gender		
Female	126	84.00%
Male	24	16.00%
Trainer Age		
18- 20	1	0.10%
21-29	74	39.40%
30-39	23	20.40%
40-49	20	16.30%
50-59	23	15.50%
60 and above	9	8.30%

The most common degree field was psychology, followed closely by education. About a third of the trainers held a master trainer certification, and just under a third held an advanced trainer certification. The majority of trainers were in their 20s and 30s, and 84% were female.

After eligible participants were identified, student demographics as well as pretest and post-test data were collected for each trainer from the archived records. The demographic characteristics of students are presented in Table 3.

Table 3. *Demographic Characteristics of Students (n = 1,195)*

Variable	Number	Percentage
Student Age		
5 and Under	22	1.84%
6-8	274	22.90%
9-11	329	27.53%
12-15	328	27.44%
16-18	115	9.62%
19 and over	127	10.62%
Student Gender		
Female	490	40.80%
Male	705	59.20%
Student Race		
White/Caucasian	574	48.00%
Asian/Pacific Islander	31	2.60%
African American	42	3.50%
Native American	5	0.40%
Hispanic/Not White	42	3.50%
Not Reported	449	41.50%
ADHD Diagnosis		
Yes	364	30.46%
No	831	69.53%

A total of 1,195 students had valid scores in this dataset, although not every student had a score for every test.   Over half of the students ranged in age from 6 to 12. Almost half of the students were Caucasian, 59% of students were male, and almost one third of students had received a prior diagnosis of ADHD.

Summary of the Results

Results for Research Question 1

The results of the multiple regression analyses used to answer the question, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *general intelligence* for students with and without ADHD?" indicate that the null hypothesis cannot be rejected. None of the variance in difference scores between pretest and post-test scores on general intelligence could be predicted by trainer degree level, degree field, certification level, pre-hire cognitive test score, or personality traits for students with or without ADHD.

Results for Research Question 2

The results of the multiple regression analyses used to answer the question, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *working memory* for students with and without ADHD?" indicate that the null hypothesis cannot be rejected. None of the variance in difference scores between pretest and post-test scores on working memory scores could be predicted by trainer degree level, degree field, certification level, pre-hire cognitive test score, or personality traits for students with or without ADHD.

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Results for Research Question 3

       The results of the multiple regression analyses used to answer the question, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *long-term memory* for students with and without ADHD?" indicate that the null hypothesis can be rejected. For students as a whole group, college degree field and trainer certification level predicted 5% of the variance in student long-term memory scores. Students with trainers holding a degree in education or master trainer certification achieved higher difference scores.

       For students without ADHD, five percent of the variance in long-term memory scores could be explained by trainer degree level, degree field, and certification level. Student scores decreased when their trainer held a post-master's degree, but increased with trainers holding a degree in education or a master trainer certification. Personality trait was not a significant predictor of long-term memory gains for any group.

Results of Research Question 4

       The results of the multiple regression analyses used to answer the question, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *processing speed* for students with and without ADHD?" indicate that the null hypothesis can be rejected. As a group, student processing speed scores could not be predicted by trainer education and experience, or by personality traits. However, for students without

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ADHD, one percent of the variance was predicted by the trainer personality trait of extroversion.

Details of the Analysis and the Results

Data Preparation

Prior to analyzing the data, the dataset was screened for missing data and outliers. The initial set of data included 217 trainers and 2,345 matching student records. Trainers who did not have student data that included both pretest and post-test scores ($n = 56$) were excluded from analysis. Students who did not have both pretest and post-test scores were excluded from the analysis ($n = 1,150$) because difference scores were used as the dependent variables. The final dataset included 150 trainers and 1,195 students. Not all student records included measures for all four constructs. Therefore, the preliminary analysis for general intelligence included 1,057 cases; the analysis for processing speed included 1,063 cases; the analysis for working memory included 1,166 cases; and the analysis for long-term memory included 1,168 cases.

To test for assumptions of normality in the data, z scores were calculated in SPSS and examined for each quantitative variable to identify extreme outliers. An *a priori* decision was made to drop scores which fell three or more standard deviations above or below the mean. Therefore, cases with z scores exceeding 3.30 (positive or negative) were excluded. A total of 46 cases were dropped. The analyses were run again, but the results were similar. Therefore, the initial analyses were retained and reported.

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A histogram and normal Q-Q plot for each quantitative predictor and outcome variable were visually inspected for normal distribution. The histograms for the four quantitative dependent variables are shown in Figure 1.
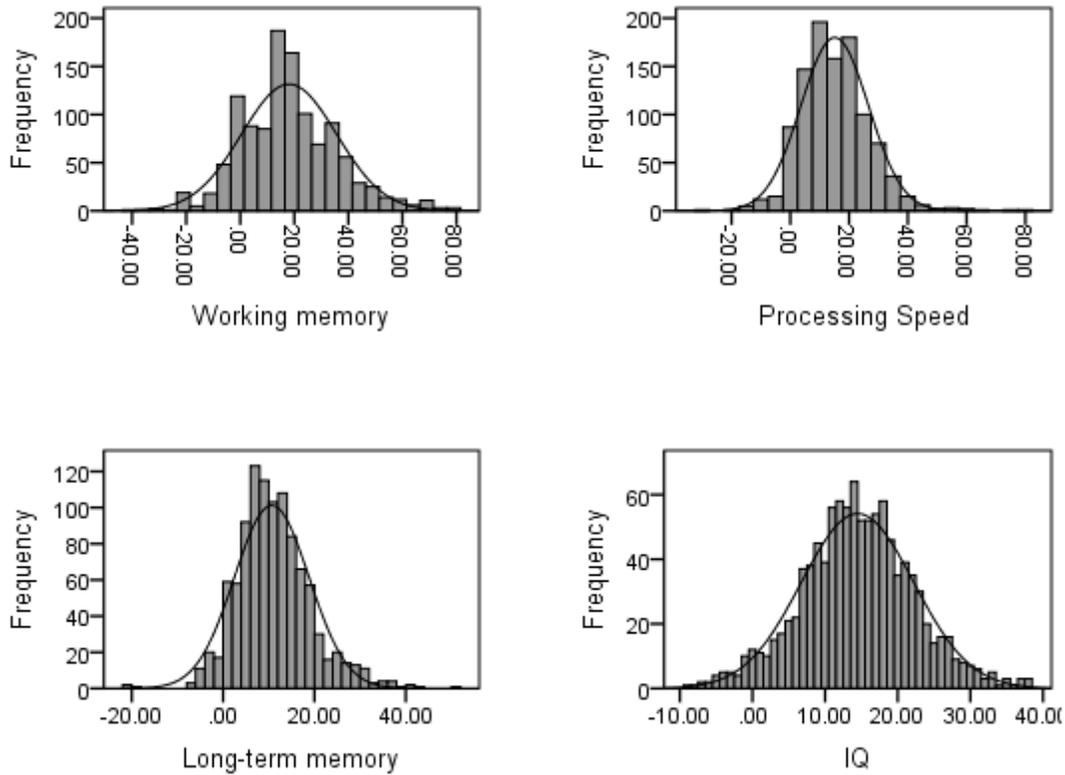
Figure 1. Histograms of dependent variables.

The histograms of difference scores on working memory, processing speed, long-term memory, and IQ show near normal distributions on all four measures. The corresponding normal Q-Q plots are shown in Figure 2.
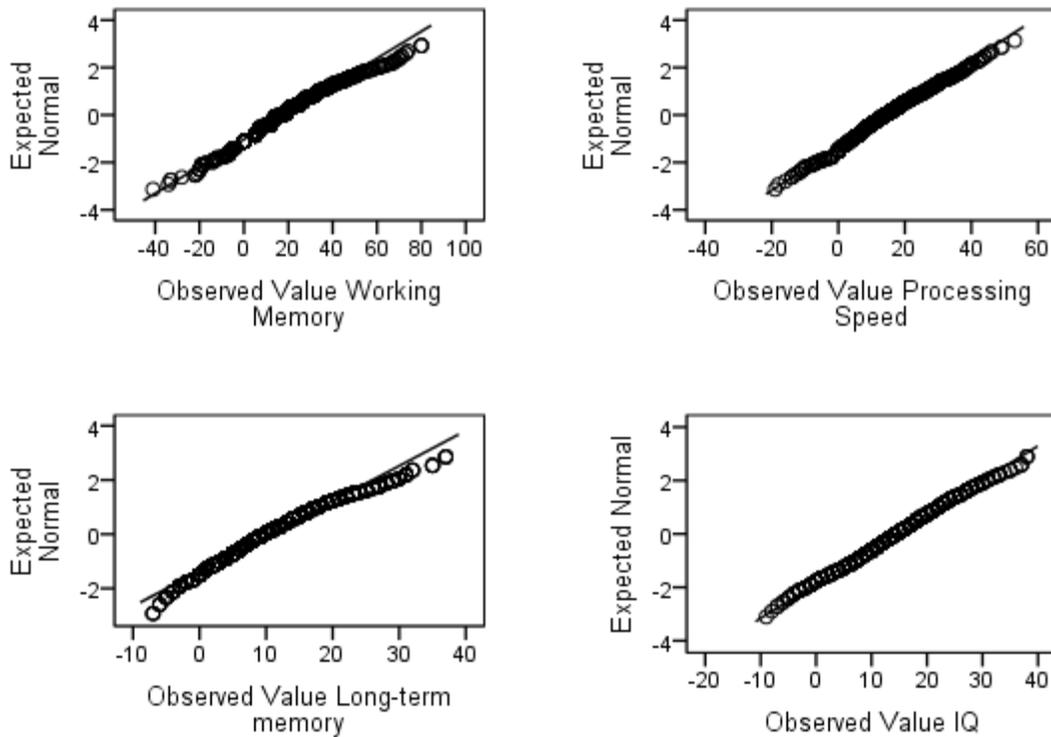
Figure 2. Normal Q-Q plots of dependent variables.

The plots show data points positioned along the diagonal line, indicating near normal distributions of scores across all four dependent measures of working memory, processing speed, long-term memory, and IQ. Histograms and normal Q-Q plots for the quantitative independent variables are shown in Figures 3 and 4. The variable of pre-hire cognitive speed test score was transformed using a Log_{10} linear transformation to make the distribution more normal, but no scores were excluded. This method is considered conventional for reaction-time variables (Warner, 2013). The restricted range of the variable (2-6 minutes) and the floor effect indicated the need for the transformation.
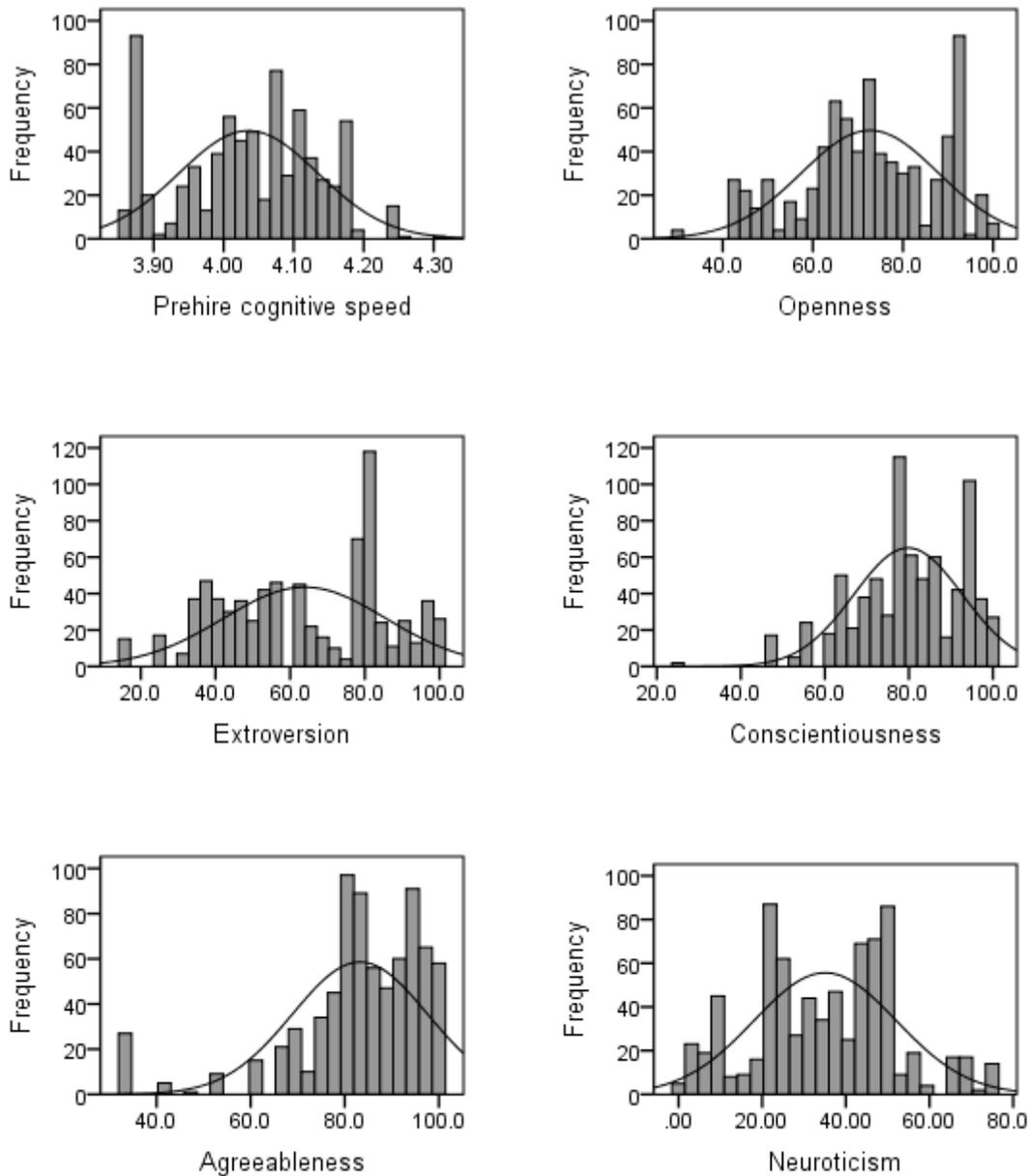
Figure 3. Histograms of quantitative independent variables.

Histograms show multi-modal but near normal distributions for all quantitative predictor variables except agreeableness, which revealed a slightly negative skew.
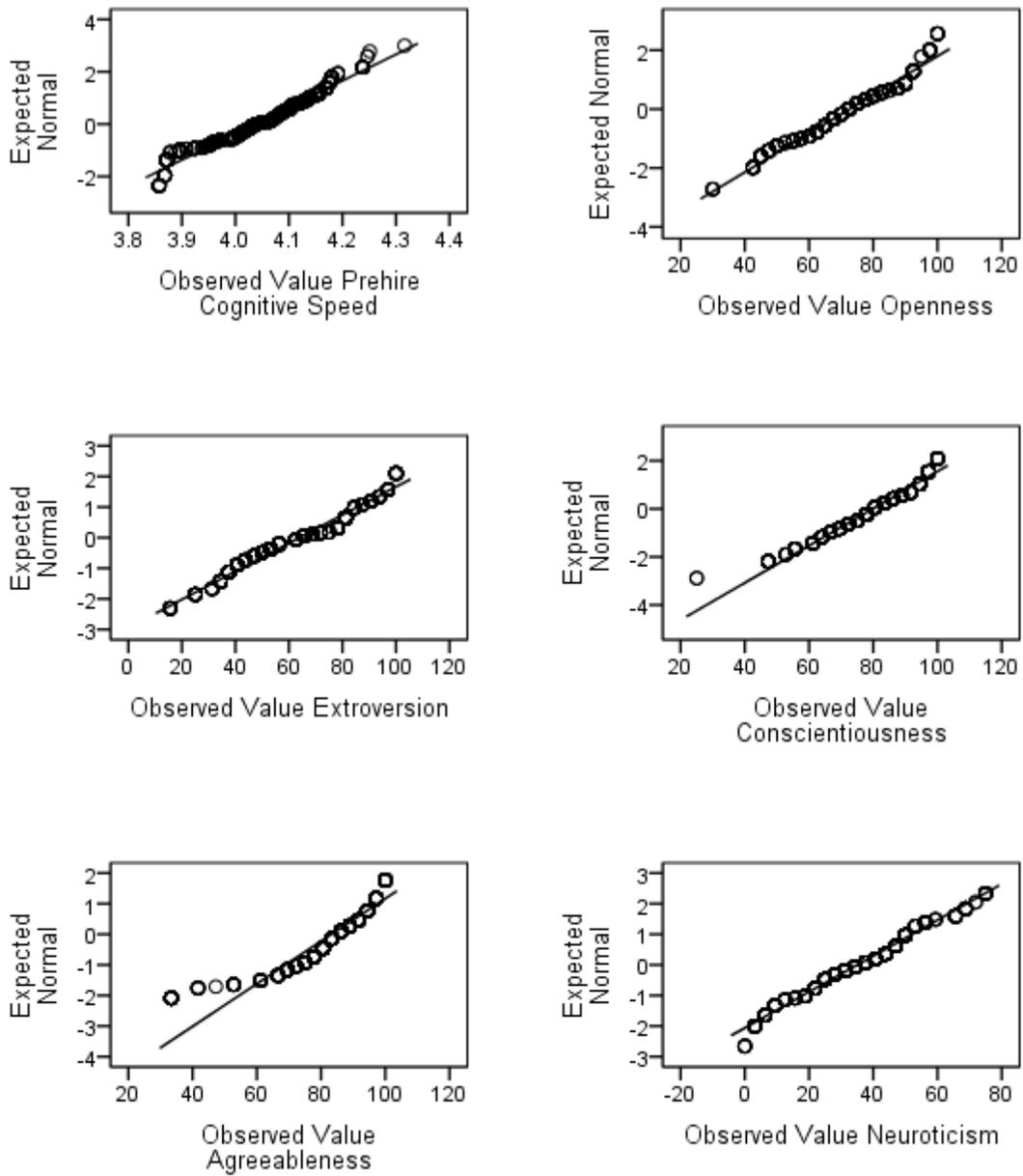
Figure 4. Normal Q-Q plots of quantitative independent variables.

Plots show data points positioned along the diagonal line, indicating near normal distributions of scores across all quantitative independent variables except for

agreeableness. A Levene's test for homogeneity of variance was also conducted on each

quantitative predictor and outcome variable. The test for homogeneity of variance was

not violated for any of the quantitative outcome or predictor variables. The results are

shown in Table 4.

Table 4. *Test for Homogeneity of Variance*

Variable	Levene statistic	p
IQ	0.02	.87
Working Memory	0.27	.60
Long-term memory	0.02	.87
Processing Speed	1.48	.22
Pre-hire cognitive test	0.06	.80
Openness	0.08	.78
Conscientiousness	0.36	.55
Agreeableness	0.01	.94
Extroversion	0.01	.91
Neuroticism	0.88	.35

To test for between group differences, an analysis of variance was conducted on

gain (difference) scores for students with and without ADHD, and there were no

significant differences between the groups on general intelligence: $F (1, 1054) = .07$, $p =$

$.79$, working memory: $F (1, 1163) = .15$, $p = .69$, long-term memory: $F (1, 1165) = .45$,

$p = .49$, and processing speed: $F (1, 1060) = 1.45$, $p = .22$.

Bivariate Analyses

Table 5 shows the bivariate correlations between the dependent variables (IQ,

long-term memory, processing speed, and working memory) and four of the independent

variables (trainer degree level, degree field, certification level, and pre-hire cognitive test score). Trainer degree level was positively correlated with student working memory scores ($r = .08$, $p = .005$). Trainer degree field was positively correlated with student IQ scores ($r = .09$, $p = .003$), student working memory scores ($r = .06$, $p = .03$), and student processing speed scores ($r = .10$, $p = .001$). Trainer certification level was negatively correlated with student working memory scores ($r = -.12$, $p = .00$), and positively correlated with student long-term memory scores ($r = .09$, $p = .001$). Trainer pre-hire cognitive test scores were positively correlated with student IQ scores ($r = .08$, $p = .03$) and student long-term memory scores ($r = .13$, $p = .001$). These correlations are examined through multiple regression analysis in each of the hypotheses sub-sections of this chapter.

Table 5. *Correlations between Student Scores and Trainer Degree Level, Degree Field, Certification Level, and Pre-Hire Cognitive Test Score*

Variable	IQ		Working Memory		Processing Speed		Long-term Memory	
	R	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Degree Level	.06	.06	.08*	.005	-.008	.79	.03	.35
Degree Field	.09*	.003	.06*	.03	.10*	.001	.009	.77
Certification Level	-.02	.59	-.12*	.00	.02	.54	.09*	.001
Cognitive Score	.08*	.03	.04	.28	-.07	.07	.13*	.001

* p < .05

Table 6 shows the bivariate correlations between the dependent variables (IQ, long-term memory, processing speed, and working memory) and trainer personality traits (openness, conscientiousness, extroversion, agreeableness, and neuroticism). The trainer personality traits of openness and agreeableness were not significantly correlated with any student scores. The trainer personality trait of conscientiousness was positively correlated with student IQ scores ($r = .08$, $p = .006$).

Table 6. *Correlations between Student Scores and Trainer Personality Traits*

Variable	IQ		Working Memory		Processing Speed		Long-term Memory	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Openness	-.03	.29	.04	.20	.06	.06	-.01	.65
Conscientiousness	.08*	.006	.05	.08	.06	.05	.06	.05
Extroversion	-.02	.47	-.01	.62	.07*	.03	-.02	.50
Agreeableness	.04	.22	.03	.29	.03	.32	-.01	.73
Neuroticism	-.07*	.01	-.07*	.009	.02	.54	-.04	.22

* $p < .05$

The trainer personality trait of extroversion was positively correlated with student processing speed scores ($r = .07$, $p = .03$). The trainer personality trait of neuroticism was negatively correlated with student IQ scores ($r = -.07$, $p = .01$) and student working memory scores ($r = -.07$, $p = .009$). These correlations are further examined through multiple regression analyses in each subsequent section.

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Research Question 1

The first research question asked, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *general intelligence* for students with and without ADHD?"

Analysis. Four multiple regression analyses were conducted to examine predictors of general intelligence. First, multicollinearity was examined by calculating the collinearity statistics of variance inflation factor (VIF) and tolerance for all outcome variables. The results are shown for the education and experience model in Table 7.

Table 7. *Collinearity Statistics for Education and Experience Model with IQ*

	Collinearity		Durbin-
	Tolerance	VIF	Watson
Degree Level			
Less than BA	0.81	1.23	
Master's	0.69	1.44	
Post-Master's	0.92	1.08	
Degree Field			
Education	0.55	1.79	
Medical/OT/SLP	0.77	1.29	
Other	0.68	1.45	
Certification Level			
Advanced	0.39	2.52	
Master	0.38	2.58	
Pre-hire Cognitive Test	0.75	1.32	
model			1.73

Collinearity statistics for the personality trait model are shown in Table 8. In both models, all tolerance values were above the recommended threshold of 0.20 and all VIF values were below the recommended threshold of 10. Independence of residuals was examined through the Durbin-Watson statistic. All values met the suggested criteria of near 2.00.

Table 8. *Collinearity Statistics for Personality Model with IQ*

	Tolerance	VIF	Durbin-Watson
Openness	0.82	1.21	
Extroversion	0.73	1.37	
Conscientiousness	0.68	1.47	
Agreeableness	0.70	1.43	
Neuroticism	0.60	1.67	
model			1.71

Next, the first regression analysis was conducted on the education and experience model. The analysis was conducted using all records of students with a reported IQ score ($n = 686$). Difference scores between pretest and post-test were used as the dependent variable; and the following were the predictor variables: trainer education level (dummy coded as less than bachelor's degree, bachelor's degree, master's degree, and post-master's degree), trainer degree field (dummy coded as psychology, education, medical-related, and other), trainer certification level (dummy coded as basic certification, advanced certification, and master certification), and trainer pre-hire cognitive test score (quantitative variable operationalized in number of seconds taken to complete the test). To account for multiple tests on the same dataset, the Bonferroni-adjusted alpha level was

set at .01. The overall regression was not statistically significant: F (9,676) = 1.9, $p =$

.05, R = .16, R^2 = .025, adjusted R^2 = .01. Therefore, variance in general intelligence

scores for all students cannot be predicted by the model. The results of the first

regression analysis are reported in Table 9.

Table 9. *Results of Regression Analysis for Trainer Education and Experience on*
General Intelligence Scores

Independent Variable	b	SE_b	β	t	p	95% CI
Constant	10.97	1.69		6.5	.00	[7.64,14.29]
Degree Level						
Less than BA	-1.4	1.78	-.03	-.78	.35	[-4.88,2.10]
Master's	.05	.96	.002	.05	.96	[-1.83,2.10]
Post-Master's	-2.09	2.22	-.037	-.95	.35	[-6.45,2.26]
Degree Field						
Education	2.06	.88	.12	2.35	.02	[.338,3.78]
Medical/OT/SLP	1.39	1.50	.04	.93	.35	[-1.54,4.33]
Other	1.79	.84	.09	2.13	.03	[.033,.142]
Certification Level						
Advanced	.53	1.01	.03	.52	.60	[-1.46,2.51]
Master	-.11	1.00	-.007	-.11	.91	[-2.08,1.86]
Pre-hire Cognitive Test	.014	.007	.08	1.95	.05	[.000,.029]

Note. Bachelor's degree, psychology, and basic trainer certification are the reference categories for in the
regression. CI = confidence interval.

The second analysis was conducted using a split file of student records by

ADHD diagnosis and the following predictor variables: trainer education level (4 levels),

trainer degree field (4 levels), trainer certification level (3 levels), and trainer pre-hire

processing speed score. To account for multiple tests on the same dataset, the

Bonferroni-adjusted alpha level was set at .01. The overall regression on predictors of

general intelligence scores for students with ADHD was not statistically significant: F (9, 211) = 1.7, p = .08, R = .26, R^2 = .07, adjusted R^2 = .03. Based on this analysis, it can be concluded that none of the variance in general intelligence scores for students with ADHD can be predicted by the model. The overall regression on predictors of general intelligence scores for students without ADHD was also not statistically significant: F (9, 455) = 1.9, p = .05, R = .19, R^2 = .04, adjusted R^2 = .02. Based on this analysis, it can be concluded that none of the variance in general intelligence scores for students without ADHD can be predicted by the model.

A follow-up Fisher's z transformation of the R values for each model was conducted to test whether the correlation coefficients for each model were significantly different from one another. Using the formula in *Equation 3* and a Table of Probabilities for the z Distribution (Kenny, 1987), it can be concluded that the difference between the correlation coefficients is not significant: z = .90, p = .36.

$$z = \frac{z_1 - z_2}{\sqrt{\frac{1}{n_{1-3}} + \frac{1}{n_{2-3}}}} = \frac{.2661 - .1923}{\sqrt{\frac{1}{221-3} + \frac{1}{465-3}}} = \frac{.0738}{.0816} = .90 \qquad (3)$$

The third regression analysis was conducted on all student records using trainer personality trait as the predictor variable. There are five levels of the personality trait variable: openness, conscientiousness, extroversion, agreeableness, and neuroticism. To account for multiple tests on the same dataset, the Bonferroni-adjusted alpha level was set at .01. Results of this regression analysis are reported in Table 10.

Table 10. *Results of Regression Analysis for Trainer Personality Traits on General Intelligence Scores*

Independent Variable	b	SE_b	β	t	p	95% CI
Constant	15.03	2.77		5.4	.00	[9.58,20.47]
Openness	-.01	.02	-.03	-.77	.44	[-.049,.022]
Extroversion	-.02	.01	-.05	-1.3	.21	[-.043,.009]
Conscientiousness	.04	.02	.07	1.8	.07	[-.004,.083]
Agreeableness	-.01	.02	-.01	-.32	.75	[-.050,.036]
Neuroticism	-.03	.02	-.07	-1.7	.09	[-.063,.005]

Note. CI = confidence interval.

The results of the overall regression were not significant: F (5, 1043) = 2.5, p = .02, R = .11, R^2 = .01, adjusted R^2 = .007. Based on this analysis, it can be determined that none of the variance in general intelligence scores can be predicted by the model.

The fourth regression analysis was conducted using a split file of student records by ADHD diagnosis and trainer personality trait as the predictor variable. There are five levels of the personality trait variable: openness, conscientiousness, extroversion, agreeableness, and neuroticism. The results of the overall regression for students with ADHD were not significant: F (5, 323) = 1.3, p = .26, R = .14, R^2 = .02, adjusted R^2 = .005. Based on this analysis, it can be determined that variance in general intelligence scores of students with ADHD cannot be predicted by the model. The results of the overall regression for students without ADHD were also not significant: F (5, 713) = 2.5, p = .03, R = .13, R^2 = .017, adjusted R^2 = .01. Based on this analysis, it can be determined that none of the variance in general intelligence scores of students without

ADHD was predicted by the model.

A follow-up Fisher's *z* transformation of the *R* values for each model was conducted to test whether the correlation coefficients for each model were significantly different from one another. Using the formula in *Equation 4*, a standard transformation of *r* to Fisher's *z* table, and a table of probabilities for the *z* distribution (Kenny, 1987), we can conclude that the difference between the correlation coefficients is not significant: $z = .09, p = .93$.

$$z = \frac{z_1 - z_2}{\sqrt{\frac{1}{n_{1-3}} + \frac{1}{n_{2-3}}}} = \frac{.1409 - .1307}{\sqrt{\frac{1}{329-3} + \frac{1}{719-3}}} = \frac{.0102}{.1127} = .09 \tag{4}$$

Results. In answering Research Question 1, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *general intelligence* for students with and without ADHD?", the null hypothesis is not rejected. Variance in general intelligence scores could not be predicted by trainer degree level, degree field, certification level, or pre-hire cognitive test score for students with or without ADHD.

Research Question 2

The second research question asked, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *working memory* for students with and without ADHD?"

Analysis. Four multiple regression analyses were conducted to examine

predictors of working memory scores. First, multicollinearity was examined by

calculating the collinearity statistics of variance inflation factor (VIF) and tolerance for

all outcome variables. The results are shown in Tables 11 and 12.

Table 11. *Collinearity Statistics for Education and Experience Model with Working Memory*

| | Collinearity | | Durbin- |
	Tolerance	VIF	Watson
Degree Level			
Less than BA	0.82	1.23	
Master's	0.72	1.44	
Post-Master's	0.92	1.08	
Degree Field			
Education	0.57	1.79	
Medical/OT/SLP	0.78	1.29	
Other	0.71	1.45	
Certification Level			
Advanced	0.40	2.52	
Master	0.39	2.58	
Pre-hire Cognitive Test	0.76	1.32	
model			1.87

Table 12. *Collinearity Statistics for Personality Model with Working Memory*

| | | | Durbin- |
	Tolerance	VIF	Watson
Openness	0.83	1.21	
Extroversion	0.73	1.36	
Conscientiousness	0.69	1.45	
Agreeableness	0.70	1.43	
Neuroticism	0.61	1.64	
model			1.92

For both models, all tolerance values were above the recommended threshold of 0.20 and

all VIF values were below the recommended threshold of 10. Independence of residuals

was examined through the Durbin-Watson statistic. All values met the suggested criteria

of near 2.00.

The first regression analysis on working memory results are shown in Table 13.

Table 13. *Results of Regression Analysis for Trainer Education and Experience on Student Working Memory Scores*

Independent Variable	b	SE_b	β	t	p	95% CI
constant	19.40	3.62		5.35	.00	[12.28,26.52]
Degree Level						
Less than BA	-.154	3.72	-.017	-.417	.67	[-8.85,5.75]
Master's	3.05	2.06	.064	1.47	.14	[-1.00,7.10]
Post-Master's	3.11	4.82	.024	.645	.51	[-6.36,12.58]
Degree Field						
Education	2.78	1.85	.072	1.50	.13	[-.859,6.42]
Medical/OT/SLP	1.16	3.25	.015	.357	.72	[-5.22,7.55]
Other	1.44	1.81	.035	.800	.42	[-2.10,5.00]
Certification Level						
Advanced	-3.55	2.17	-.094	-1.63	.10	[-7.81,.712]
Master	-6.60	2.13	-.179	-3.08	.002	[-10.81,-2.40]
Pre-hire Cognitive Test	.009	.016	.023	.540	.58	[-.023,.040]

Note. Bachelor's degree, psychology, and basic trainer certification are the reference categories for in the regression.

The analysis used difference scores between pretest and post-test as the dependent

variable, and the following predictor variables: trainer education level (dummy coded as

less than bachelor's degree, bachelor's degree, master's degree, and post-master's

degree), trainer degree field (dummy coded as psychology, education, medical-related,

and other), trainer certification level (dummy coded as basic certification, advanced certification, and master certification), and trainer pre-hire cognitive test score (quantitative variable operationalized in number of seconds taken to complete the test). To account for multiple tests on the same dataset, the Bonferroni-adjusted alpha level was .01. The overall regression was not statistically significant: $F(9,736) = 2.06$, $p = .03$, $R = .16$, $R^2 = .025$, adjusted $R^2 = .01$, indicating that none of the variance in working memory scores was predicted by the model.

The second analysis was conducted using a split file of student records by ADHD diagnosis and the following predictor variables: trainer education level (4 levels), trainer degree field (4 levels), trainer certification level (3 levels), and trainer pre-hire processing speed score. To account for multiple tests on the same dataset, the Bonferroni-adjusted alpha level was .01. The overall regression on predictors of working memory scores for students without ADHD was not statistically significant: $F(9, 505) = 1.7$, $p = .08$, $R = .17$, $R^2 = .03$, adjusted $R^2 = .01$. The overall regression on predictors of working memory scores for students with ADHD was also not statistically significant: $F(9, 221) = 2.1$, $p = .03$, $R = .28$, $R^2 = .08$, adjusted $R^2 = .04$, indicating that none of the variance in working memory scores for students with or without ADHD was predicted by the model.

A follow-up Fisher's z transformation of the R values for each model was conducted to test whether the correlation coefficients for each model were significantly different from one another. Using the formula in *Equation 5*, a standard transformation of r to Fisher's z table, and a table of probabilities for the z distribution (Kenny, 1987), it can be concluded that the difference between the correlation coefficients is not

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significant: $z = 1.47, p = .14$

$$z = \frac{z_1 - z_2}{\sqrt{\frac{1}{n_{1-3}} + \frac{1}{n_{2-3}}}} = \frac{.1717 - .2877}{\sqrt{\frac{1}{515-3} + \frac{1}{231-3}}} = \frac{.116}{.079} = 1.47 \tag{5}$$

The third regression analysis was conducted on all student records using trainer personality trait as the predictor variable. There are five levels of the personality trait variable: openness, conscientiousness, extroversion, agreeableness, and neuroticism. Results are presented in Table 14. To account for multiple tests on the same dataset, the Bonferroni-adjusted alpha level was .01. The results of the overall regression were approaching significance: $F(5, 1152) = 2.5, p = .03, R = .10, R^2 = .01$, adjusted $R^2 = .006$, indicating that none of the variance in working memory scores for all students was predicted by trainer personality traits.

Table 14. *Results of Regression Analysis for Trainer Personality Traits on Student Working Memory Scores*

Independent Variable	b	SE_b	β	t	p	95% CI
constant	20.28	6.00		3.37	.001	[8.49,32.07]
Openness	.069	.039	.056	1.73	.083	[-.009,.146]
Extroversion	-.060	.029	-.071	-2.07*	.039	[-.117,-.003]
Conscientiousness	.025	.048	.018	.521	.602	[-.069,.119]
Agreeableness	-.021	.048	-.015	-.439	.661	[-.115,.073]
Neuroticism	-.095	.038	-.094	-2.51	.012	[-.168,-.021]

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The fourth regression analysis was conducted using a split file of student records by ADHD diagnosis and trainer personality trait as the predictor variable. There are five levels of the personality trait variable: openness, conscientiousness, extroversion, agreeableness, and neuroticism. The results of the overall regression for students with ADHD were not significant: $F(5, 346) = 1.05$, $p = .38$, $R = .12$, $R^2 = .01$, adjusted $R^2 = .001$. Based on this analysis, it can be determined that variance in working memory scores for students with ADHD cannot be predicted by the model. The results of the overall regression for students without ADHD were also not significant: $F(5, 799) = 2.2$, $p = .06$, $R = .12$, $R^2 = .013$, adjusted $R^2 = .007$. Based on this analysis, it can be determined that variance in working memory scores for students without ADHD cannot be predicted by the model.

A follow-up Fisher's z transformation of the R values for each model was conducted to test whether the correlation coefficients for each model were significantly different from one another. Using the formula in *Equation 6*, a standard transformation of r to Fisher's z table, and a table of probabilities for the z distribution (Kenny, 1987), it can be concluded that the difference between the correlation coefficients is not significant: $z = 0$, $p = 1.00$.

$$z = \frac{z_1 - z_2}{\sqrt{\frac{1}{n_1-3}+\frac{1}{n_2-3}}} = \frac{.1206 - .1206}{\sqrt{\frac{1}{352-3}+\frac{1}{805-3}}} = \frac{0.0}{.0632} = 0 \qquad (6)$$

Results. In answering Research Question 2, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive

test score predict training outcomes in *working memory* for students with and without

ADHD?", the null hypothesis cannot be rejected. None of the variance in working

memory scores could be predicted by trainer degree level, degree field, certification level,

pre-hire cognitive test score, or personality trait.

Research Question 3

The third research question asked, "Do cognitive trainer characteristics of

personality traits, college major, degree level, certification level, and pre-hire cognitive

test score predict training outcomes in *long-term memory* for students with and without

ADHD?"

Analysis. Four multiple regression analyses were conducted to examine

predictors of long-term memory. First, multicollinearity was examined by calculating the

collinearity statistics of variance inflation factor (VIF) and tolerance for all outcome

variables. All tolerance values were above the recommended threshold of 0.20 and all

VIF values were below the recommended threshold of 10. Independence of residuals was

examined through the Durbin-Watson statistic. All values met the suggested criteria of

near 2.00. The results are shown for the education and experience model in Table 15,

and for the personality trait model in Table 16.

Table 15. *Collinearity Statistics for Education and Experience Model with Long-term Memory*

| | Collinearity | | Durbin-Watson |
	Tolerance	VIF	
Degree Level			
Less than BA	0.85	1.17	
Master's	0.73	1.36	
Post-Master's	0.92	1.09	
Degree Field			
Education	0.57	1.74	
Medical/OT/SLP	0.80	1.25	
Other	0.71	1.41	
Certification Level			
Advanced	0.41	2.41	
Master	0.41	2.43	
Pre-hire Cognitive Test	0.75	1.33	
model			1.90

Table 16. *Collinearity Statistics for Personality Model with Long-term Memory*

	Tolerance	VIF	Durbin-Watson
Openness	0.83	1.20	
Extroversion	0.74	1.36	
Conscientiousness	0.69	1.44	
Agreeableness	0.70	1.43	
Neuroticism	0.61	1.63	
model			1.77

The first regression analysis used difference scores between pretest and post-test as the dependent variable, and the following predictor variables: trainer education level (dummy coded as less than bachelor's degree, bachelor's degree, master's degree, and post-master's degree), trainer degree field (dummy coded as psychology, education,

medical-related, and other), trainer certification level (dummy coded as basic

certification, advanced certification, and master certification), and trainer pre-hire

cognitive test score (quantitative variable operationalized in number of seconds taken to

complete the test). To account for multiple tests on the same dataset, the Bonferroni-

adjusted alpha level was set at .01. The results of the regression are shown in Table 17.

Table 10. *Results of Regression Analysis for Trainer Education and Experience on Student Long-Term Memory Scores*

Independent Variable	b	SE_b	β	t	p	95% CI
constant	5.15	1.57		3.27	.001	[2.06,8.23]
Degree Level						
Less than BA	1.55	1.61	.038	.963	.336	[-1.61,4.72]
Master's	-.451	.895	-.021	-.503	.615	[-2.20,1.30]
Post-Master's	-9.96	2.09	-.071	-1.89	.058	[-8.07,.140]
Degree Field						
Education	2.14	.805	.126	2.66*	.008	[.563,3.72]
Medical/OT/SLP	.019	1.41	.001	.014	.989	[-2.75,2.78]
Other	.102	.785	.006	.130	.897	[-1.43,1.64]
Certification Level						
Advanced	2.03	.942	.123	2.16	.031	[.187,3.88]
Master	2.86	.928	.177	3.08*	.002	[1.04,4.68]
Pre-hire Cognitive Test	.015	.007	.085	2.06	.039	[.001,.028]

Note. Bachelor's degree, psychology, and basic trainer certification are the reference categories for in the regression.
* p < .01

The overall regression was statistically significant: $F (9, 737) = 3.95$, $p = .00$, $R = .21$, R^2

$= .05$, adjusted $R^2 = .03$. Based on this analysis, it can be concluded that 5% of the

variance in long-term memory scores for all students can be predicted by the model. An

analysis of the contributions of the individual predictors in the model included an examination of the t ratios for each regression slope. Two variables were significant predictors of long-term memory scores: trainer degree field and certification level.

The positive slope for trainer degree field ($b = 2.14$) was statistically significant: t (737) = 2.66, $p = .008$, indicating that student scores on long-term memory increased 2.14 points if the trainer had a degree in education. However, trainer degree field of education predicted less than 1% of the variance in scores, as indicated by the sr^2 value of .009.

The positive slope for master certification ($b = 2.86$) was also statistically significant: t (737) = 3.08, $p = .002$, indicating that student scores on long-term memory increased 2.86 points if the trainer held a master certification. However, master certification predicted just 1% of the variance in scores, as indicated by the sr^2 value of .01.

The second analysis was conducted using a split file of student records by ADHD diagnosis and the following predictor variables: trainer education level (4 levels), trainer degree field (4 levels), trainer certification level (3 levels), and trainer pre-hire processing speed score. To account for multiple tests on the same dataset, the Bonferroni-adjusted alpha level was .01. The overall regression on predictors of long-term memory scores for students with ADHD was not statistically significant: F (9, 221) = 1.5, $p = .13$, $R = .24$, $R^2 = .06$, adjusted $R^2 = .02$. Based on this analysis, it can be concluded that none of the variance in long-term memory scores for students with ADHD can be predicted by the model.

The overall regression on predictors of long-term memory scores for students

without ADHD was statistically significant: F (9, 506) = 3.8, p = .00, R = .25, R^2 = .06, adjusted R^2 = .05. Based on this analysis, it can be concluded that 5% of the variance in long-term memory scores for students without ADHD can be predicted by the model. An analysis of the contributions of the individual predictors in the model included an examination of the t ratios for each regression slope. Three variables were significant predictors of long-term memory scores for students without ADHD: trainer degree level, trainer degree field, and certification level. The negative slope for trainer degree level (b = -7.6) was statistically significant: t (506) = -2.9, p = .004, indicating that student scores on long-term memory decreased 7.6 points if the trainer had a post-master's degree. However, trainer degree level predicted just 1.5% of the variance in scores, as indicated by the sr^2 value of .015.

The positive slope for trainer degree field (b = 2.954) was statistically significant: t (506) = 3.09, p = .002, indicating that student scores on long-term memory increased 2.95 points if the trainer had a degree in education. However, trainer degree field of education predicted just 1.7% of the variance in scores, as indicated by the sr^2 value of .017. Finally, the positive slope for master certification (b = 3.27) was statistically significant: t (506) = 3.27, p = .002, indicating that student scores on long-term memory increased 3.27 points if the trainer held a master certification. However, master certification predicted just 1.7% of the variance in scores, as indicated by the sr^2 value of .017.

A follow-up Fisher's z transformation of the R values for each model was conducted to test whether the correlation coefficients for each model were significantly

different from one another. Using the formula in *Equation 7*, a standard transformation

of *r* to Fisher's *z* table, and a table of probabilities for the *z* distribution (Kenny, 1987), it

can be concluded that the difference between the correlation coefficients is not

significant: $z = .134$, $p = .89$.

$$z = \frac{z_1 - z_2}{\sqrt{\frac{1}{n_{1-3}} + \frac{1}{n_{2-3}}}} = \frac{.2448 - .2554}{\sqrt{\frac{1}{231-3} + \frac{1}{516-3}}} = \frac{.0106}{.079} = .134 \qquad (7)$$

The third regression analysis was conducted on all student records using trainer

personality trait as the predictor variable. The results of the regression are illustrated in

Table 18.

Table 18. *Results of Regression Analysis for Trainer Personality Traits on Student Long-Term Memory Scores*

Independent Variable	b	SE$_b$	B	t	p	95% CI
Constant	11.46	2.64		1.33	.000	[6.28,16.64]
Openness	-.002	.017	-.003	-.107	.915	[-.036,.032]
Extroversion	-.012	.013	-.033	-.953	.341	[-.037,.013]
Conscientiousness	.039	.021	.066	1.87	.062	[-.002,.081]
Agreeableness	-.031	.021	-.051	-1.46	.144	[-.072,.011]
Neuroticism	-.017	.017	-.040	-1.05	.290	[-.050,.015]

There are five levels of the personality trait variable: openness, conscientiousness,

extroversion, agreeableness, and neuroticism. To account for multiple tests on the same

dataset, the Bonferroni-adjusted alpha level was .01. The results of the overall regression were not significant: $F(5, 1154) = 1.5$, $p = .19$, $R = .08$, $R^2 = .006$, adjusted $R^2 = .002$. Based on this analysis, it can be determined that no variance in long term memory scores can be predicted by the model.

The fourth regression analysis was conducted using a split file of student records by ADHD diagnosis and trainer personality trait as the predictor variable. There are five levels of the personality trait variable: openness, conscientiousness, extroversion, agreeableness, and neuroticism. The results of the regression for students with ADHD were not significant: $F(5, 347) = 1.7$, $p = .12$, $R = .16$, $R^2 = .024$, adjusted $R^2 = .01$. Based on this analysis, it can be determined that variance in long term memory scores of students with ADHD cannot be predicted by the model. The results of the regression for students without ADHD were also not significant: $F(5, 800) = 1.4$, $p = .22$, $R = .09$, $R^2 = .009$, adjusted $R^2 = .002$. Based on this analysis, it can be determined that variance in long term memory scores of students without ADHD cannot be predicted by the model. A follow-up Fisher's z transformation of the R values for each model was conducted to test whether the correlation coefficients for each model were significantly different from one another. Using the formula in *Equation 8*, a standard transformation of r to Fisher's z table, and a table of probabilities for the z distribution (Kenny, 1987), it can be concluded that the difference between the correlation coefficients is not significant: $z = 1.13$, $p = .26$.

$$z = \frac{z_1 - z_2}{\sqrt{\frac{1}{n_{1-3}} + \frac{1}{n_{2-3}}}} = \frac{.1614 - .0902}{\sqrt{\frac{1}{353-3} + \frac{1}{806-3}}} = \frac{.0712}{.063} = 1.13 \qquad (8)$$

Results. In answering Research Question 3, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *long-term memory* for students with and without ADHD?", the null hypothesis is rejected. For students as a whole group, college major and trainer certification level were significant predictors of long-term memory gains. For students without ADHD, degree level, degree field, and certification level were significant predictors of long-term memory scores. Personality trait was not a significant predictor of long-term memory gains.

Research Question 4

The final research question asked, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *processing speed* for students with and without ADHD?"

Analysis. Four multiple regression analyses were conducted to examine predictors of processing speed. First, multicollinearity was examined by calculating the collinearity statistics of variance inflation factor (VIF) and tolerance for all outcome variables. The results are shown for the education and experience model in Table 19, and for the personality trait model in Table 20. All tolerance values were above the recommended threshold of 0.20 and all VIF values were below the recommended

threshold of 10. Independence of residuals was examined through the Durbin-Watson

statistic. All values met the suggested criteria of near 2.00.

Table 19. *Collinearity Statistics for Education and Experience Model with Processing Speed*

| | Collinearity | | Durbin- |
	Tolerance	VIF	Watson
Degree Level			
Less than BA	0.83	1.17	
Master's	0.71	1.36	
Post-Master's	0.92	1.09	
Degree Field			
Education	0.56	1.74	
Medical/OT/SLP	0.78	1.25	
Other	0.69	1.41	
Certification Level			
Advanced	0.39	2.41	
Master	0.38	2.43	
Pre-hire Cognitive Test	0.76	1.33	
model			1.90

Table 20. *Collinearity Statistics for Personality Model with Processing Speed*

| | | | Durbin- |
	Tolerance	VIF	Watson
Openness	0.82	1.20	
Extroversion	0.73	1.37	
Conscientiousness	0.68	1.46	
Agreeableness	0.70	1.42	
Neuroticism	0.61	1.65	
model			1.88

The first analysis used difference scores between pretest and post-test as the

dependent variable, and the following predictor variables: trainer education level (dummy

coded as less than bachelor's degree, bachelor's degree, master's degree, and post-master's degree), trainer degree field (dummy coded as psychology, education, medical-related, and other), trainer certification level (dummy coded as basic certification, advanced certification, and master certification), and trainer pre-hire cognitive test score (quantitative variable operationalized in number of seconds taken to complete the test). To account for multiple tests on the same dataset, the Bonferroni-adjusted alpha level was set at .01. The results of the analysis are shown in Table 21.

Table 21. *Results of Regression Analysis for Trainer Education and Experience on Student Processing Speed Scores*

Independent Variable	*B*	*SE_b*	*β*	*t*	*p*	95% CI
constant	9.60	1.88		5.09	.000	[5.90,13.3]
Degree Level						
Less than BA	1.51	1.95	.032	.771	.441	[-.233,5.35]
Master's	-.214	2.46	-.009	-.203	.839	[-2.29,1.86]
Post-Master's	-4.11	2.46	-.066	-1.66	.096	[-8.95,.734]
Degree Field						
Education	1.25	.965	.066	1.30	.194	[-.641,3.14]
Medical/OT/SLP	.405	1.67	.010	.242	.809	[-2.87,3.86]
Other	2.16	.931	.106	2.32	.020	[.336,3.99]
Certification Level						
Advanced	1.60	1.12	.086	1.42	.155	[-.607,3.81]
Master	1.20	1.12	.066	1.07	.281	[-.991,3.40]
Pre-hire Cognitive Test	-.012	.008	-.065	-1.49	.136	[-.029,.004]

Note. Bachelor's degree, psychology, and basic trainer certification are the reference categories for the regression.

The overall regression was not statistically significant: $F_{(9,682)} = 1.7$, $p = .08$, $R = .15$,

$R^2 = .02$, adjusted $R^2 = .009$. Therefore, variance in processing speed scores for all

students cannot be predicted by the model.

The second analysis was conducted using a split file of student records by ADHD

diagnosis and the following predictor variables: trainer education level (4 levels), trainer

degree field (4 levels), trainer certification level (3 levels), and trainer pre-hire processing

speed score. The overall regression on predictors of processing speed scores for students

with ADHD was not statistically significant: $F (9, 209) = .53$, $p = .85$, $R = .15$, $R^2 = .02$,

adjusted $R^2 = .02$. Based on this analysis, none of the variance in processing speed scores

for students with ADHD can be predicted by the model. The overall regression on

predictors of processing speed scores for students without ADHD was also not

statistically significant: $F (9, 463) = 2.1$, $p = .02$, $R = .20$, $R^2 = .04$, adjusted $R^2 = .02$,

indicating that none of the variance in processing speed scores for students without

ADHD was predicted by the model.

A follow-up Fisher's z transformation of the R values for each model was

conducted to test whether the correlation coefficients for each model were significantly

different from one another. Using the formula in *Equation 9*, a standard transformation

of r to Fisher's z table, and a table of probabilities for the z distribution (Kenny, 1987), it

can be concluded that the difference between the correlation coefficients was not

significant: $z = .63$, $p = .52$.

$$z = \frac{z_1 - z_2}{\sqrt{\frac{1}{n_{1}-3} + \frac{1}{n_{2}-3}}} = \frac{.2027 - .1511}{\sqrt{\frac{1}{473-3} + \frac{1}{219-3}}} = \frac{.0516}{.082} = .63 \qquad (9)$$

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The third regression analysis was conducted on all student records using trainer personality trait as the predictor variable. There are five levels of the personality trait variable: openness, conscientiousness, extroversion, agreeableness, and neuroticism. To account for multiple tests on the same dataset, the Bonferroni-adjusted alpha level was set at .01. The results of the overall regression were not significant: $F(5, 1049) = 3.0$, $p = .01$, $R = .12$, $R^2 = .01$, adjusted $R^2 = .01$. Based on this analysis, it can be determined that none of the variance in processing speed scores can be predicted by the model. The results of the regression are shown in Table 22.

Table 22. *Results of Regression Analysis for Trainer Personality Traits on Student Long-Term Memory Scores*

Independent Variable	b	SE_b	β	t	p	95% CI
constant	-1.15	3.01		-.383	.702	[-7.06,4.76]
Openness	.016	.020	.028	.824	.410	[-.022,.055]
Extroversion	.030	.015	.073	2.02*	.043	[.001,.058]
Conscientiousness	.057	.024	.087	2.35*	.019	[.009,.104]
Agreeableness	.013	.024	.019	.522	.602	[-.035,.060]
Neuroticism	.048	.019	.101	2.56	.011	[.011,.085]

The fourth regression analysis was conducted using a split file of student records by ADHD diagnosis and trainer personality trait as the predictor variable. There are five levels of the personality trait variable: openness, conscientiousness, extroversion, agreeableness, and neuroticism. The results of the overall regression for students with

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ADHD were not significant: $F(5, 321) = .77$, $p = .57$, $R = .11$, $R^2 = .01$, adjusted $R^2 = .004$. Based on this analysis, it can be determined that variance in processing speed scores for students with ADHD cannot be predicted by the model. The results of the overall regression for students without ADHD were significant: $F(5, 721) = 3.8$, $p = .002$, $R = .16$, $R^2 = .026$, adjusted $R^2 = .02$. Based on this analysis, it can be determined that 2.6% of the variance in processing speed scores for students without ADHD were predicted by the model.

An analysis of the contributions of the individual personality trait levels in the model included an examination of the t ratios for each regression slope. The positive slope for extroversion ($b = .05$) was statistically significant: $t(721) = 2.8$, $p = .005$, indicating that student scores on processing speed increased by .05 points for every one unit increase in trainer extroversion score . Extroversion predicted just 1% of the variance in scores, as indicated by the sr^2 value of .01.

A follow-up Fisher's z transformation of the R values for each model was conducted to test whether the correlation coefficients for each model were significantly different from one another. Using the formula in *Equation 10*, a standard transformation of r to Fisher's z table, and a table of probabilities for the z distribution (Kenny, 1987), it can be concluded that the difference between the correlation coefficients is not significant: $z = .76$, $p = .46$.

$$z = \frac{z_1 - z_2}{\sqrt{\frac{1}{n_{1-3}} + \frac{1}{n_{2-3}}}} = \frac{.1614 - .1104}{\sqrt{\frac{1}{727-3} + \frac{1}{327-3}}} = \frac{.051}{.067} = .76 \tag{10}$$

Results. In answering Research Question 4, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *processing speed* for students with and without ADHD?", the null hypothesis can be rejected. As a group, student processing speed scores could not be predicted by trainer education and experience.

For students as a whole group, none of the variance in processing speed scores was predicted by personality trait. However, for students without ADHD, 2.6% of the variance in processing speed was predicted by personality trait, and 2% of the variance was predicted by the trainer personality trait of extroversion. A complete summary of the results is presented in Table 23. Based on a Bonferroni correction, the alpha level is .01 for all analyses.

Table 23. *Summary of Results*

Research Question	Test	Results	Significance Level
1. Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *general intelligence* for students with and without ADHD?	Multiple regression	No significant education and experience predictors.	*p* = .05
		No significant personality trait predictors.	*p* = .02
2. Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *working memory* students with and without ADHD?	Multiple regression	No significant education and experience predictors.	*p* = .03
		No significant personality trait predictors.	*p* = .03
			Table continues

Table 23 (continued)

Research Question	Test	Results	Significance Level
3. Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *long-term memory* for students with and without ADHD?	Multiple regression	Degree field was a significant predictor overall with a very small effect size.	*p = .008*
		Certification was a significant predictor overall with a very small effect size.	*p = .002*
		Degree field was a significant predictor with a very small effect size for students without ADHD.	*p = .002*
		Degree level was a significant predictor with a very small effect size for students without ADHD.	*p = .004*
		Certification level was a significant predictor with a very small effect size for students without ADHD.	*p = .002*
		Personality trait was not a significant predictor.	*p = .19*
4. Do cognitive trainer characteristics of personality type, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *processing speed* for students with and without ADHD?	Multiple regression	Education and experience were not significant predictors.	*p = .08*
		Personality was approaching significance as a predictor overall.	*p = .01*
			Table continues

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Table 23 (continued)

Research Question	Test	Results	Significance Level
		Personality trait of extroversion was a significant predictor with a very small effect size for students without ADHD.	$p = .002$

Conclusion

This chapter presented the results of 16 multiple regression analyses, four analyses to answer each of the four research questions. Each research question was addressed using two regression models: an education and experience model and a personality trait model. Each research question was analyzed using both models on all student data, followed by split file analyses based on the diagnosis of ADHD or not. The next chapter discusses the results from this study along with suggestions for extending this line of research in the future.

CHAPTER 5. RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

This chapter begins with a description of the research problem, the study's significance, and a short summary of the existing literature that supported the study. Then, a summary of the results is presented, followed by a detailed interpretation and discussion of the findings. The chapter concludes with the relationship of the findings to the existing literature, the limitations of the current study, and suggestions for future research.

Summary of the Results

The current study examined the association between cognitive trainer characteristics (degree level, degree field, certification level, pre-hire cognitive test score, and personality traits) and student outcomes on scores of general intelligence, working memory, long-term memory, and processing speed. This study was important because knowledge of the predictive value of these trainer characteristics may assist cognitive training program administrators in maximizing the benefit of training by appropriate matching of trainers and students with and without ADHD.

In Chapter 2, a review of the associated literature was presented and several conclusions were drawn. First, prior research revealed that impaired executive functions—including attention, memory, and processing speed—are characteristic of individuals with ADHD (Brown, 2006; Martel et al., 2007; Martinussen et al., 2005; McQuade et al., 2011). Second, prior research on face-to-face cognitive training is

dominated by efficacy studies that revealed improvements in attention, processing speed, working memory, long-term memory, phonemic awareness, auditory and visual processing, logic and reasoning, sensory motor skills, oppositional behavior, general intelligence, and school performance (Carpenter, 2009; Jedlicka, 2012; Luckey, 2006; Luckey, 2009; Pfister, 2013). However, prior studies have focused on factors related to intervention tasks that predicted cognitive training gains rather than the characteristics of cognitive trainers that may predict training outcomes. It was unknown how the characteristics of cognitive trainers might predict training outcomes for students with or without ADHD.

Third, prior research has linked instructor characteristics with student achievement across multiple learning environments including general education classrooms (Garcia, Kupczynski, & Holland, 2011; Kneipp, Kelly, Biscoe, & Richard, 2010), special education classrooms (Carlson, Lee, & Schroll-Westat, 2004; Edmonds, 2010), tutoring programs (Putra, 2013), corporate training (Ghosh, Satyawadi, Joshi, Ranjan, & Singh, 2012), and mental health clinics (Charlebois, Vitaro, Normandeau, Brendgen, & Rondeau, 2004; Siqueland et al., 2000).

Finally, research on self-efficacy supported the theoretical framework for the current study, suggesting that the relational dynamics of one-on-one cognitive training lend themselves towards efficacy-building through verbal persuasion and mastery experiences. Dynamic feedback—such as that provided by cognitive trainers during each mental training task—is a vital and necessary form of efficacy-building verbal persuasion (Hattie & Timperley, 2007). Positive communication from significant others and

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instructional connectedness are relational moderators of learning (Bandura, 1997; Martin & Dowson, 2009; Schunk & Miller, 2002), so the current study sought to expand the application of self-efficacy theory to the influence of cognitive trainer characteristics on student learning outcomes.

The current study used a quantitative, non-experimental design with multiple regression analyses of cognitive trainer education and employment questionnaires, cognitive trainer personality inventories, and archived student data to answer the primary research question, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in general intelligence, working memory, long-term memory, and processing speed for students with and without ADHD?".

Results for Research Question 1

The results of the multiple regression analyses used to answer the question, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *general intelligence* for students with and without ADHD?" indicate that the null hypothesis cannot be rejected. Variance in general intelligence gain (difference) scores could not be predicted by trainer degree level, degree field, certification level, pre-hire cognitive test score, or personality traits.

Results for Research Question 2

The results of the multiple regression analyses used to answer the question, "Do

cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *working memory* for students with and without ADHD?" indicate that the null hypothesis cannot be rejected. Variance in working memory scores could not be predicted by trainer degree level, degree field, certification level, pre-hire cognitive test score, or personality traits.

Results for Research Question 3

The results of the multiple regression analyses used to answer the question, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *long-term memory* for students with and without ADHD?" indicate that the null hypothesis can be rejected. For students as a whole group, college degree field and trainer certification level predicted 5% of the variance in student long-term memory scores. Higher scores were predicted for students with trainers holding a degree in education, and master trainer certification.

For students without ADHD, 5% of the variance in long-term memory scores could be predicted by trainer degree level, degree field, and certification level. Student scores were predicted to decrease when their trainer held a post-master's degree, but predicted to increase with trainers holding a degree in education or a master trainer certification. Personality trait was not a significant predictor of long-term memory gains for any group.

Results of Research Question 4

The results of the multiple regression analyses used to answer the question, "Do cognitive trainer characteristics of personality traits, college major, degree level, certification level, and pre-hire cognitive test score predict training outcomes in *processing speed* for students with and without ADHD?" indicate that the null hypothesis can be rejected. As a group, student processing speed scores could not be predicted by trainer education and experience, or by personality traits. However, for students without ADHD, 2.6% of the variance in processing speed was predicted by personality trait. 2% of the variance was predicted by the trainer personality trait of extroversion.

Discussion of the Results

Trainer Personality Traits

The results of the current study were unexpected. Given the volume of prior literature on the association of instructor characteristics and student achievement, similar findings were expected for this study. The findings for trainer personality were especially incongruent with the expectations, considering the theoretical support for relational influences on learning (Bandura, 1993). In short, cognitive trainer personality was not a strong predictor of student outcomes. Across three student measures (general intelligence, working memory, and long-term memory), cognitive trainer personality traits did not predict variance in scores for students with or without ADHD; and only predicted 1% of variance in processing speed scores for students without ADHD. Thus,

99% of the variance in student scores remains unexplained by the personality traits model. Therefore, the practical significance of the finding is extremely low. Indeed, other factors not related to trainer personality are contributing to student cognitive training outcomes.

Trainer Education and Experience

The findings for the predictive value of trainer education and experience were also unexpected. The education and experience model predicted none of the variance in general intelligence or working memory for any students. That is, trainer degree level, degree field, certification level, and pre-hire cognitive test score did not predict student outcomes in general intelligence or working memory.

Trainer degree level was only a significant predictor for long-term memory outcomes for students without ADHD. It did not predict outcomes on the remaining three cognitive skills for students with or without ADHD. Students who had trainers with degrees higher than a master's were predicted to achieve lower scores on long-term memory. However, trainer degree level only predicted 1.5% of the variance in scores, so the practical significance of this finding is very limited.

Although trainer certification was a predictor of long-term memory outcomes, it did not predict general intelligence, working memory, or processing speed outcomes. Although not statistically significant, there was a trend of lower working memory scores—6 points lower for students as a whole group and 12 points lower for students with ADHD—when trainers held master trainer certification. Master certification is an

indicator of cognitive training experience, so it was expected that students of trainers with a master certification would achieve greater outcomes. Indeed, master trainer certification did predict higher long-term memory scores for all students. Despite these contradictory and unexpected finding, the effect sizes for trainer certification as an individual predictor in each of these analyses were too low for any practical significance. At least 97% of the variance in working and long-term memory scores still remains unexplained.

Finally, degree field was a significant predictor of long-term memory outcomes for students. When trainers held a degree in education, all students were predicted to achieve higher scores on long-term memory. No other associations for trainer degree field were noted.

Although there were several statistically significant associations with small effect sizes between cognitive trainer characteristics and student outcomes, none of the findings have great practical significance. Statistically, the null hypothesis was rejected for two of the four research questions. However, the effect sizes were extremely small which indicates that the magnitude of the findings is very small. The question that remains is, "How significant is significant enough?" It is unclear whether the results support a change in trainer-student matching protocols. It is unclear whether the results support a change in cognitive trainer hiring protocols. The results suggest that trainer personality does not influence student results; that trainers who have a degree in education may get better results with all students; and that trainers with master level certification have inconsistent results with students who have ADHD. The following section explores how

those three conclusions add to and align with current research and the field of educational

psychology.

Discussion of the Conclusions

Trainer Personality and Student Results

Trainer personality was not a strong predictor of student outcomes in this study.

This finding is not consistent with the existing literature reviewed in Chapter Two. One

conclusion is that the intervention may indeed be more important than the characteristics

of the person delivering the intervention. Prior studies of one one-on-one cognitive

training focused on the efficacy of the program rather than the characteristics of the

clinician delivering the program (Carpenter, 2009; Jedlicka, 2012; Luckey, 2006; Luckey,

2009; Pfister, 2013). The consistency of student gains across studies may actually

indicate that it is the intervention rather than the clinician that contributes most to the

efficacy.

A related notion is that the cognitive training intervention used by the trainers in

the current study is consistent across students. The one-on-one cognitive training

program is standardized across centers, and trainers receive identical training in the

delivery of the program.   This may not be typical of an instructor-student-outcome study.

When teacher personality is studied across grade levels and locations, curriculum may be

a confounding variable—the nature of schooling dictates that a variety of different

curricula were used for instruction (Fenderson, 2011; Rushton, Morgan, & Richard,

2007). In essence, the curriculum was held constant in the current study, which

contributed to a more isolated measure of personality traits and a stronger conclusion that

personality traits are not a key player in student cognitive training outcomes.

Education Degree Field and Student Results

Students of trainers with degrees in education scored higher on measures of both

working memory and long-term memory. This finding suggests that trainers with

education degrees may have some preservice training in working with students who have

special needs. Based on the research showing an increase in efficacy for working with

students who have delays and disabilities, placement in inclusive classrooms during

preservice student teaching is a growing practice among teacher education programs

(Atiles, Jones, & Kim, 2012). It may also mean that they may have prior classroom

experience working with students who have ADHD. Because ADHD affects 8.8% of

children (Visser et al., 2014), it is certainly plausible that trainers with prior classroom

experience have worked with students who have ADHD. However, prior experience was

not collected as part of the Cognitive Trainer Questionnaire in the current study, so this

conclusion cannot be drawn without further examination.

Master Certification and Student Results

As expected, when trainers held a master certification, long-term memory scores

were significantly higher for all students. However, working memory scores for their

students with ADHD were 12 points lower. One possible explanation of this finding is

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found in the literature on teacher burn-out. Because master certification is earned with experience, master trainers have been delivering the cognitive training program for three to 14 years. They may have exhausted their patience for working with challenging students. Research on teacher burnout indicates that special education teachers are the most likely to suffer the stress leading to burnout (Martin, 2010); and a recent study showed that burnout is most highly correlated with 6-10 years of teaching experience (Seferoglu, Yildiz, & Yücel, 2014). However, burnout data was not collected as part of the current study and a firm conclusion cannot be drawn. Further, the trend of lower scores for students with ADHD was observed but was not statistically significant.

Limitations

The current study has several limitations. First, the use of archived student data constrains the use of the data to what is available. The measure of cognitive skills was limited to a single score per construct. Multiple measures of cognitive skills—such as another standardized test, teacher report, or parent inventory—may have made the findings more robust.

Another limitation to the study is the inherent challenge of self-reports. Participants in the study self-reported their pre-hire cognitive test score, and the analysis relied on the assumption of accurate reporting. Participants were asked to check their employment record before beginning the questionnaire, but there is no method for assuring that occurred. The personality inventory is also a subjective measure of personality constructs. Further, participation in an employment-related study may have

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influenced the way participants answered the personality trait questions. One participant called to talk about the possibility that trainers may have two distinct personalities—one for work and one for "real-life". Finally, the diagnosis of ADHD was also self-reported by parents of the students. The analysis also assumed the report of diagnosis was accurate.

A final limitation to the study is the design. As a correlational study, conclusions or causal inferences about the relationships between the variables were not possible, and the variables could not be controlled or manipulated by the researcher.

Recommendations for Future Research or Interventions

The current study would have benefitted through the collection of additional information from the participants. A recommendation for future research would be to collect and examine data on specific coursework taken by trainers and specific prior experience working with students who have ADHD or other special education needs. This information may help interpret the current findings.

Another recommendation is to conduct a mixed-methods study to observe instructional dynamics and feedback given to students by trainers. Differences in rapport or small deviations from training protocols may have influenced the outcomes. A survey of students and trainers about their relationships would be an interesting extension, and provide an opportunity to more deeply explore the application of social cognitive theory to the cognitive training environment. This design would also provide a vehicle for exploring why trainers with master certification might be associated with lower cognitive

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training gains for students with ADHD.

A third recommendation is to conduct a randomized, control group study. The students in the current study self-selected for cognitive training. By randomly recruiting participants, the potential for selection bias would be minimized. This study design could also incorporate a measure of cognitive constructs with multiple forms to reduce testing effects from pretesting and post-testing with the same form of the instrument.

Finally, a study of teacher personality traits and student achievement should be conducted across classrooms using the same curriculum. For example, a list of schools using an established curriculum could be obtained from the publisher and the sample could be recruited from that list. By controlling the curriculum as a potential confounding variable, a more unadulterated measure of personality traits as a predictor of student achievement could be obtained than that of prior studies in the literature.

Conclusion

The current study examined the association between cognitive trainer characteristics (degree level, degree field, certification level, pre-hire cognitive test score, and personality traits) and student outcomes on scores of general intelligence, working memory, long-term memory, and processing speed. This study topic was chosen because knowledge of the predictive value of these trainer characteristics may assist cognitive training program administrators in maximizing the benefit of training through targeted recruitment and appropriate matching of trainers and students with and without ADHD. The current study sought to expand the application of self-efficacy theory to the influence

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of cognitive trainer characteristics on student learning outcomes. Based on this theoretical framework and the existing literature on instructor personality and student achievement, the expected finding was that trainer personality traits would predict student outcomes. The findings, however, were not as expected.

There were two conclusions drawn from the findings which will contribute to the existing literature. First, trainers with a degree in education had students with higher cognitive test scores. Second, personality traits were not a key contributor to student training outcomes. Although these were statistically significant findings, the practical significance is limited. Finally, students with ADHD had lower cognitive test scores when their trainers held a master trainer certification, although the trend was not statistically significant. However, it is information worth disseminating to training program administrators with the suggestion that they look for similar trends between trainers and students while waiting for future research to dig more deeply into the predictive value of cognitive trainer characteristics on student outcomes.

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APPENDIX A. STATEMENT OF ORIGINAL WORK

Academic Honesty Policy

Capella University's Academic Honesty Policy (3.01.01) holds learners accountable for the integrity of work they submit, which includes but is not limited to discussion postings, assignments, comprehensive exams, and the dissertation or capstone project.

Established in the Policy are the expectations for original work, rationale for the policy, definition of terms that pertain to academic honesty and original work, and disciplinary consequences of academic dishonesty. Also stated in the Policy is the expectation that learners will follow APA rules for citing another person's ideas or works.

The following standards for original work and definition of *plagiarism* are discussed in the Policy:

> Learners are expected to be the sole authors of their work and to acknowledge the authorship of others' work through proper citation and reference. Use of another person's ideas, including another learner's, without proper reference or citation constitutes plagiarism and academic dishonesty and is prohibited conduct. (p. 1)

> Plagiarism is one example of academic dishonesty. Plagiarism is presenting someone else's ideas or work as your own. Plagiarism also includes copying verbatim or rephrasing ideas without properly acknowledging the source by author, date, and publication medium. (p. 2)

Capella University's Research Misconduct Policy (3.03.06) holds learners accountable for research integrity. What constitutes research misconduct is discussed in the Policy:

> Research misconduct includes but is not limited to falsification, fabrication, plagiarism, misappropriation, or other practices that seriously deviate from those that are commonly accepted within the academic community for proposing, conducting, or reviewing research, or in reporting research results. (p. 1)

Learners failing to abide by these policies are subject to consequences, including but not limited to dismissal or revocation of the degree.

Statement of Original Work and Signature

I have read, understood, and abided by Capella University's Academic Honesty Policy (3.01.01) and Research Misconduct Policy (3.03.06), including Policy Statements, Rationale, and Definitions.

I attest that this dissertation or capstone project is my own work. Where I have used the ideas or words of others, I have paraphrased, summarized, or used direct quotes following the guidelines set forth in the APA *Publication Manual*.

Learner name
and date   Amy Lawson Moore 1/22/2015

Mentor name
and school   Debora Adler, Harold Abel School of Psychology

APPENDIX B. COGNITIVE TRAINER QUESTIONNAIRE

Part 1. Trainer Education, Employment, and Demographic Questions

1. Please enter your first name and the first initial of your last name. (ie. John D.)

2. Please enter the name and location of the center where you are employed.

3. What is the highest level of education you have completed?
    a. Bachelor's degree
    b. Master's degree
    c. Post-master's specialist
    d. Doctoral degree
    e. Other _____

4. Please select the category that most closely matches the major field of study for your bachelor's degree:
    a. Education
    b. Psychology
    c. Sociology/Social Work
    d. Occupational Therapy
    e. Nursing/Medical
    f. Other _____

5. If applicable, please select the major field of study that most closely matches your graduate degree.
    a. Education
    b. Psychology
    c. Sociology/Social Work
    d. Occupational Therapy
    e. Nursing/Medical
    f. Other _____

6. Please select your cognitive trainer certification level.
    a. Level 1: Certified Trainer
    b. Level 2: Advanced Trainer
    c. Level 3: Master Trainer

7. Please enter the month and year you began employment as a cognitive trainer.

8. Please enter your score from the screening you completed during your pre-employment interview.

9. Which category below includes your age?
    a. 18-20
    b. 21-29
    c. 30-39
    d. 40-49
    e. 50-59
    f. 60 or older

10. What is your gender?
    a. Female
    b. Male

11. What is your ethnicity?
    a. American Indian or Alaskan Native
    b. Asian or Pacific Islander
    c. Black or African American
    d. Hispanic or Latino
    e. White/Caucasian
    f. Prefer not to answer
    g. Other _____