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An Analysis of Targeted Tier II Cognitive Interventions on Reading Achievement

Shannon K. Kovack
kovack@marshall.edu

AN ANALYSIS OF TARGETED TIER II COGNITIVE INTERVENTIONS ON READING ACHIEVEMENT

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by

Shannon K. Kovack, M.A.

Approved by
Fred Jay Krieg, Ph.D., Committee Chair
Sandra S. Stroebel, Ph.D.
Stephen L. O'Keefe, Ph.D.

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ABSTRACT

An Analysis of Targeted Tier II Cognitive Interventions on Reading Achievement

The purpose of this study was to determine which cognitive intervention based on Cattell-Horn-Carroll (CHC) theory was most effective at increasing student reading achievement. Ninety students who performed in the bottom one-third on the Virginia Standards of Learning (VA SOL) test from a rural school district in VA were placed into three instructional groups: 1) a control group, in which the teacher utilized the same instructional strategies from previous years, 2) a "teacher selected" treatment group, in which the teachers determined the students' cognitive processing deficits and chose an intervention, and 3) a "tested" treatment group, in which students were administered the Woodcock Johnson III Tests of Cognitive Abilities (WJ-III) and assigned interventions based on the testing. Students were assessed using the end of year SOL test. Results indicated that all other interventions combined based on CHC theory (including the Comprehension-Knowledge, Visual Processing, Auditory Processing, Fluid Reasoning, and Processing Speed interventions) were more effective than memory interventions alone (including Working Memory and Long-Term Retrieval interventions) at improving reading achievement.

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Chapter I: Literature Review

The Education for All Handicapped Children Act (EHCA) was enacted in 1975 and provided funding to states, parent centers, and research centers that ensured public education for students with disabilities (Ikeda, 2012). The focus of EHCA became a three-step process in which children with disabilities were evaluated, identified, and provided with services (Ikeda, 2012). Sadly, the EHCA resulted in many children with disabilities being labeled, excluded from the general curriculum, and provided with remedial services (Ikeda, 2012), which led to these students falling further and further behind. Numerous reauthorizations and new laws aimed to remedy this injustice. With the reauthorization of the Individuals with Disabilities Education Act (IDEA) in 2004, a new emphasis was placed on "providing students with high-quality, scientifically-based instructional methods, curricular materials, and intervention strategies; early identification of learning problems; continual monitoring of the impact of instruction; design and implementation of individualized interventions; and inclusion of all students in one accountability system" (Cates, Blum, & Swerdlik, 2011, p. 4). Furthermore, IDEA reduced the use of the Discrepancy Model, which determined eligibility for a learning disability based on the difference between a student's cognitive ability and the student's academic achievement, and placed eligibility determination on the student's response to intervention (Dehn, 2006).

Three-Tiered Model of Instruction

Soon after the reauthorization of IDEA, the Response to Intervention (RTI) model emerged as a widely accepted approach aimed at providing all students with high quality instruction and struggling students with additional levels of instruction. Although there is no

universally accepted RTI model of delivery, most schools utilize a Three-Tiered Model of Instruction (Kavale & Spaulding, 2008). In a Three-Tiered Model of Instruction, all students are provided with a base level, which is referred to as academically engaged time (AET) (Cates et al., 2011). Systematically, as the tiers increase, the level of AET also increases. Cates et al. (2011) encourage the use of a series of assessments to match the three tiers. According to Cates et al. (2011), students are provided with an assessment that moves from a brief screening at the Tier 1 level to a targeted standard assessment at the Tier II level and to an individualized assessment at the Tier III level. The series of assessments would include the use of universal screening measures, diagnostic screening measures, curriculum-based evaluations, and progress monitoring tools. In the same regard, the students are provided with interventions that move from core universal curriculum to a targeted standards protocol intervention to an individualized intervention. Each intervention is based on the student's performance on the assessment provided at each tier. The purpose of implementing a Three-Tiered Model of Instruction within an educational system is to identify the educational needs of students, provide appropriate educational services to the students, prevent or minimize learning problems, and foster an educational environment that implements instruction using highly effective and efficient educational practices to teacher academics (Cates et al., 2011). In summary, the purpose of a Three-Tiered Model of Instruction is to identify the students who need additional support to meet the minimal educational standards and to provide them with the evidence-based support needed to achieve those standards.

The Three-Tiered Model of Instruction provides educators with steadfast tiers of instructional delivery. All students receive Tier I services, which is the universal curriculum. At the Tier I level students are benchmarked at least three times per school year (Fisher & Frey,

2010). Fisher & Frey (2010) stress the importance of purpose, setting, modeling, and productive group work during Tier I services. If the results of a benchmark indicate that a student is not responding to the Tier I services, the student moves to Tier II services. There the student receives either more intensive instruction or different instruction, which often takes the form of additional small-group instruction designed to complement the universal curriculum (Fisher & Frey, 2010). The students are progress monitored several times a month during Tier II services (Fisher & Frey, 2010). If the student is not responding to Tier II services, the student moves to Tier III, in which, historically, a comprehensive evaluation is completed. This comprehensive evaluation provides practitioners with information about the student's cognitive processes. This information also provides educators with data about how the student processes information, which leads to the implementation of more effective interventions. Also, in Tier III, the student is placed into a lower teacher-to-student ratio. Fisher & Frey (2010) argue for a one-to-one ratio, in which the student receives individualized lessons that target the student's weaknesses while also utilizing the student's strengths.

Effectiveness of the Three-Tiered Model of Instruction

The Three-Tiered Model of Instruction brought a new approach to delivering academics to struggling students and changed the direction of education. As a result, many researchers pursued studies that examine the effectiveness of the model. An abundance of research demonstrates the effectiveness of the Three-Tiered Model of Instruction as a prevention and instructional model (Little, 2012). Hughes & Dexter (2011) conducted a review of 13 studies and found some level of improvement on academic achievement with the implementation of a Three-Tiered Model of Instruction in every study. A Three-Tiered Model of Instruction has been shown to reduce the amount of student referrals and thus the amount of students placed in special

education (Hoover, 2010). Bender and Shores (2008) found that a Three-Tiered Model of Instruction reduced the amount of special education placements in grades K-3. Tucker & Sornson (2007) found that the number of minority students placed in special education was reduced by 45% with the implementation of a Three-Tiered Model of Instruction.

Although there is research that demonstrates the effectiveness of the Three-Tiered Model of Instruction, there is also criticism against the model. Initially, researchers criticized the lack of research based solely on Tier II interventions. After much investigation, it was found that effective Tier II interventions involve certain elements including "(1) explicit instruction in alphabetic principle and related processes; (2) early intervention and prevention; (3) small group or one-on-one instruction; (4) an effective emotional and cognitive relationship between the teacher and child; (5) instruction matched to the child's skill level" (Foorman & Moats, 2004, p. 54). Furthermore, Crone, Hawken, & Horner (2010) found that Tier II interventions that are linked to Tier I interventions are most effective. Crone et al. (2010) also argue for increased adult support and frequent progress monitoring during Tier II interventions.

Tier II Interventions

Tier II interventions that are shown to be the most effective are those that are derived from methods based on theoretical implications of cognitive neuroscience (Semrud-Clikeman, 2005). One theory based on the foundations of cognitive neuroscience is the Cattell-Horn-Carroll (CHC) theory of intelligence. CHC theory is a hierarchal framework that consists of three strata: overall cognitive functioning or g (stratum III), broad abilities (stratum II), and narrow cognitive abilities (stratum I) (Evans, Floyd, McGrew, & Leforgee, 2001). The Woodcock Johnson III Tests of Cognitive Abilities measure several CHC broad cognitive abilities including Fluid Reasoning (Gf), Comprehension-Knowledge (Gc), Short-Term Memory

(Gsm), Visual Processing (Gv), Auditory Processing (Ga), Long-Term Storage, and Retrieval (Glr), and Processing Speed (Gs) (Schrank & Flanagan, 2003).

Over 100 studies have been published examining ability and achievement based on CHC theory in the past 25 years (Flanagan, Fiorello, & Ortiz, 2010). Although much research has been conducted on the relations of ability and achievement based on CHC theory, few studies examined the effectiveness of Tier II interventions based on CHC theory. Recently, Woodcock & Miller (2012) grouped individual subtests of the Woodcock Johnson III that were proven to be most informative with clinical diagnoses. In particular, this study provided practitioners with cognitive and achievement strengths and weaknesses, as well as recommended interventions corresponding with each clinical diagnosis, including reading disabilities.

Wagner, Torgesen, & Rashotte (1994) found a relationship between information processing deficits and learning disabilities, thus placing emphasis on visual processing, auditory processing, and processing speed skills. Blair (2006) found that fluid reasoning serves as a scaffold for students, helping them acquire other abilities that are essential for achievement. Not only is reading a determining factor for success in all academic areas, reading proficiently by the end of the third grade is directly related to completing high school (Annie E. Casey Foundation, 2010). Thus, another important aspect of academic success is phonics and phonemic awareness, which places emphasis on skills in auditory processing and comprehension-knowledge.

Perhaps the strongest findings indicate that working memory plays a key part in student achievement. Correlations between working memory measures and achievement range as high as .55 to .92 (Swanson, 1995). This high correlation may be explained by the association between working memory and a broad range of academic skills including mathematical problem-solving, reading and language comprehension, and written expression (Swanson & Berninger,

1996; Swanson, Howard, & Saez, 2006). Research has consistently found that children with all types of learning disabilities and difficulties display poor working memory skills (Swanson & Berninger, 1996; Dehn, 2008). Dehn (2008) argues that the strong relationships between working memory deficits and learning disabilities suggest that working memory should be evaluated whenever a student is referred for a possible learning disability. Furthermore, Swanson, Cochran, & Ewers (1990) argue that the research indicates that working memory performance can reliably differentiate between students who have a learning disability and those who are slow learners.

Knowledge of the effectiveness of the cognitive interventions based on CHC theory would provide practitioners with an understanding of what interventions would affect reading achievement. This information would allow practitioners to individualize their targeted intervention and improve student reading achievement. Because determining each student's specific cognitive weakness requires a comprehensive evaluation, which is often time-consuming and expensive, school systems would benefit from knowing which cognitive intervention is most effective at improving reading achievement and how to determine which students need which specific interventions.

The purpose of this study was to determine which cognitive interventions based on CHC theory are most effective at increasing student reading achievement. It is difficult to disprove the strong relationship found between working memory and student achievement. Therefore, this study is organized around one primary hypothesis: memory interventions (including Working Memory and Long-Term Retrieval interventions) will prove to be more highly correlated with student reading achievement than the other cognitive interventions combined based on CHC theory (including Comprehension-Knowledge, Visual Processing, Auditory Processing, Fluid

Reasoning, and Processing Speed interventions). In answering this question, more evidence will be provided on how to serve students better at the Tier II level.

Chapter II: Method

Participants

At the beginning of the 2011-2012 school year, all third-grade students from a rural school district in Virginia took a VA SOL test, which served as the reading benchmark score. Ninety students from fifteen different classrooms who scored in bottom one-third on the VA SOL test and who were not receiving Tier III instruction were selected to participate in the current study. This study utilized a data set from the study titled "Targeted Cognitive-Based Tier II Interventions to Increase Student Achievement," which examined whether targeted cognitive-based reading interventions were more effective than traditional evidence-based Tier II reading interventions and found no significant differences (Wakefield, 2012).

Measures

Participants were categorized using two variables: (a) students who received Working Memory or Long-Term Retrieval interventions and b) students who received the other cognitive interventions based on CHC theory, which included Comprehension-Knowledge, Visual Processing, Auditory Processing, Fluid Reasoning, or Processing Speed interventions. The students who received Working Memory interventions and the students who received Long-Term Retrieval interventions were combined to form one group due to the small amount of participants who received each intervention. The effectiveness of each intervention was derived from the reading scores on the end of year SOL tests.

Procedure

As a part of a larger study that examined targeted cognitive-based Tier II interventions, there were 30 children in the control group (in which the teachers utilized the same instructional strategies from previous years), 30 children in the "teacher selected" treatment group (in which

the teachers were trained in the CHC theory and chose the cognitive interventions that they thought would be best for each child), and 30 children in the "tested" treatment group (in which the students were administered the Woodcock Johnson III Tests of Cognitive Abilities (WJ-III COG) and assigned interventions based on the test results). Six schools were part of the study. The students were divided into the groups based on their school, which were randomly selected. The teachers in both treatment groups received twelve hours of training in the CHC theory. The students in the "tested" treatment group were administered Tests 1-9 and 11-17 of the Woodcock Johnson III Tests of Cognitive Abilities (Woodcock et al., 2001) by skilled school psychology graduate students. Seven interventions were developed based on the CHC clusters (i.e., Comprehension-Knowledge, Long-Term Retrieval, Visual Processing, Auditory Processing, Fluid Reasoning, Processing Speed, and Working Memory). Two evidence-based interventions were selected for each strategy. In order to maintain fidelity, the teachers in the treatment groups were required to chart the date and duration of the interventions given and an intervention specialist observed the implementation of interventions. Several analyses examined the relationships between the cognitive interventions and the end of year SOL test scores.

Chapter III: Results

An Analysis of Variance (ANOVA) test was utilized to determine whether a statistical difference occurred between the mean of the students' SOL test scores who received the memory interventions and the mean of the students' SOL test scores who received the other interventions based on CHC theory. The ANOVA revealed no significant differences in SOL test scores.

Table 1

Analysis of Variance Summary Table, VA SOL Test Scores

Source	SS	DF	MS	F-Statistic	P-Value
Between Groups	14.504	1	14.504	.988	.322

The end of year SOL test scores were also examined to determine whether a statistical difference occurred between the mean of the students' end of the year SOL test scores who received the memory interventions and the mean of the students' end of year SOL test scores who received the other interventions based on CHC theory. The descriptive statistics of the end of year SOL scores in each group is depicted in Table 2. For students who received all other interventions based on CHC theory, the end of year SOL test scores ranged from 9 to 33. The mean was 25.25 and the standard deviation was 5.349. For students who received the memory interventions, the end of year SOL test scores ranged from 7 to 31. The mean was 21.25 and the standard deviation was 7.123.

Table 2

End of Year SOL Test Scores on the Reading Section

	N	Range	Minimum	Maximum	Mean	Std. Dev.
All Others	48	24	9	33	25.25	5.349
Memory	12	24	7	31	21.25	7.123

An ANOVA was utilized to determine whether a statistical difference occurred between the mean of the students' end of year SOL test scores who received the memory interventions and the mean of the students' end of year SOL test scores who received the other interventions based on CHC theory. The results of the ANOVA, as depicted in Table 3, show that a significant difference in the mean end of year SOL test scores between the groups was found ($F = 4.681$, $df = 1$, $p = .035$). A medium effect size of 0.302 was calculated.

Table 3

Analysis of Variance Summary Table, End of Year SOL Test Scores

Source	SS	DF	MS	F-Statistic	P-Value
Between Groups	153.600	1	53.600	4.681	.035

Chapter Four: Discussion

Statistical analyses found a significant difference in end of year SOL test scores between students who received the memory interventions and students who received all other interventions based on CHC theory. The students who received Comprehension-Knowledge, Visual Processing, Auditory Processing, Fluid Reasoning, or Processing Speed interventions had an overall higher mean score on the end of year SOL tests than the students who received Working Memory and Long-Term Retrieval interventions.

Although it was hypothesized that the students who received Working Memory and Long-Term Retrieval interventions would perform higher on the end of year SOL tests, the findings revealed the opposite of the initial theory. In this specific study, the students who received Comprehension-Knowledge, Visual Processing, Auditory Processing, Fluid Reasoning, or Processing Speed interventions had a higher mean score on the end of year SOL tests.

Given that the results disproved the initial hypothesis, an exploratory analysis was completed to examine the effectiveness of each intervention. Although the logistic regression was not statistically significant, when looking at rank ordering, Auditory Processing interventions had the greatest effect on the end of year SOL test scores with a beta coefficient of -21.426. Long-Term Retrieval interventions and Working Memory interventions had the next two greatest effects on the end of year SOL test scores with beta coefficients of -21.049 and -20.510. Finally, Processing Speed interventions had a beta coefficient of -19.817 and Fluid Reasoning interventions had a beta coefficient of -18.900. The end of year SOL test scores of the students who received Visual Processing and Comprehension-Knowledge interventions were withheld from this analysis due to the small amount of participants that received these two interventions.

These findings argue that third-grade students performing in the bottom one-third on the VA SOL test would benefit from Auditory Processing interventions. This study supports the research that holds that Auditory Processing plays a key role in student reading achievement (Kavale & Forness, 2000). Additionally, these results contradict the research of Armbruster, Lehr, & Osborn (2001) who found that prevention and interventions implemented prior to the third grade increased the reading skills of 85 to 90 percent of poor readers. The outcome of this study proposes that providing struggling third-grade students with Auditory Processing interventions may increase their overall reading achievement levels.

Using the same data set, Wakefield (2012) found no significant difference when comparing the effectiveness of targeted cognitive-based reading interventions and traditional evidence-based Tier II reading interventions. Another topic using the same data set that needs investigation is examining which specific interventions were most effective at improving reading achievement scores on the end of year SOL tests. Also, future research should investigate the effectiveness of cognitive interventions based on CHC theory's effect on student achievement from a larger participant pool, so that each intervention's effectiveness could be determined.

This study has a limitation that needs to be taken into consideration when interpreting the results of the analysis. The sample of students selected from a rural school district in VA may not be reflective of students in the general United States. Furthermore, the sample is only representative of students receiving targeted interventions who performed in the bottom one-third on the VA SOL test. Consequently, it is difficult to generalize these results.

Overall, results of this study showed that the students who received all other cognitive interventions based on CHC theory (which included Comprehension-Knowledge, Visual Processing, Auditory Processing, Fluid Reasoning, or Processing Speed interventions) had a

higher average score on the end of year SOL tests than the students who received the memory interventions (which included Working Memory and Long-Term Retrieval interventions). Furthermore, Auditory Processing interventions had the greatest effect on the end of year SOL test scores followed by Long-Term Retrieval and Working Memory interventions.

Appendix

IRB Approval Letter

MARSHALL UNIVERSITY
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Office of Research Integrity
Institutional Review Board
401 11th St., Suite 1300
Huntington, WV 25701

FWA 00002704

IRB1 #00002205
IRB2 #00003206

October 17, 2012

Fred Krieg, Ph.D.
Psychology Department

RE: IRBNet ID# 274494-2
At: Marshall University Institutional Review Board #2 (Social/Behavioral)

Dear Dr. Krieg:

Protocol Title:	[274494-2] Targeted Based Cognitive TIER II Interventions to Increase Student Achievement
Expiration Date:	October 19, 2013
Site Location:	MU
Submission Type:	Continuing Review/Progress Report APPROVED
Review Type:	Exempt Review

The above study was approved for an additional 12 months by the Marshall University Institutional Review Board #2 (Social/Behavioral) Designee. The approval will expire October 19, 2013. Since this approval is within 30 days of the expiration date, the fixed anniversary date of 10/19 was maintained. Continuing review materials should be submitted no later than 30 days prior to the expiration date.

If you have any questions, please contact the Marshall University Institutional Review Board #2 (Social/ Behavioral) Coordinator Michelle Woomer, B.A., M.S at (304) 696-4308 or woomer3@marshall.edu. Please include your study title and reference number in all correspondence with this office.

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