
COGNITION, METACOGNITION, AND ACHIEVEMENT OF COLLEGE STUDENTS WITH LEARNING DISABILITIES

Guy Trainin and H. Lee Swanson

Abstract. This study examined the way successful college students with LD compensated for their deficits in phonological processing. *Successful* was defined as average or above-average grades in college coursework. The study compared the cognitive and metacognitive performance of students with and without LD (N=40). Although achievement levels for both groups were comparable, students with LD scored significantly lower than students without LD in word reading, processing speed, semantic processing, and short-term memory. Differences were also found between groups in self-regulation and number of hours of studying. Results showed that students with LD compensated for their processing deficits by relying on verbal abilities, learning strategies, and help seeking.

Guy Trainin, Ph.D., University of Nebraska-Lincoln.
H. Lee Swanson, Ph.D., University of California-Riverside.

Despite their persisting academic difficulties, adults with learning disabilities (LD) are enrolling in postsecondary education in increasing numbers (Newman & Cameto 1993; Henderson, 1999; Wagner & Blackorby, 1996). A major impetus behind this growth has been legislation and educational reform in K-12 settings. These changes in public policy, in turn, have increased funding, services, and efforts to identify and serve students with LD in school, thus producing more high-school graduates who are eligible for college entrance. Parallel to these developments, postsecondary institutions now grapple with the issues of serving college students with LD, guided by section 504 of the Rehabilitation Act (1977) (as quoted in Adelman & Vogel, 1993) and the Americans with Disabilities Act (ADA) of 1990. As a result of the increased efficacy of K-12 education for students with LD, this group is now the largest group of college students with disabilities (Henderson, 1999).

Research suggests that college students with LD have significant difficulties in multiple academic domains (e.g., Vogel & Adelman, 1992; Wilczenski, 1993). Foreexample, reports on students with LD indicate problems in reading, writing, math, and foreign language. They are at risk for failure in their courses and at increased risk for dropping out of college beyond the freshman year compared with their nonlearning disabled (NLD) peers (Vogel & Adelman, 1992; Wilczenski, 1993). At the same time, however, studies on colleges with adequate academic support show that students with LD can attain normative levels of achievement (McGuire, Hall, & Litt, 1991; Vogel & Adelman, 1992). The question is how do students with these difficulties compensate for their deficits?

One of the ways college students with LD may compensate for their cognitive difficulties is by relying on metacognition; that is, consciously controlling actions

that are too complex to be controlled automatically. Metacognition is defined by Zimmerman (1986) as the ability to adjust behavioral, environmental functioning in response to changing academic demands. Pintrich (1994) defines academic metacognition as a construct comprised of three major elements: (a) active control over learning-related behaviors such as when, how much, and with whom a student is learning; (b) self-regulation of motivation and affect, in which students learn how to control their emotions and even use them in goal setting; (c) control over various cognitive strategies for learning, such as rehearsal and memory strategies.

Use of metacognitive strategies may be linked to efficient ways to improve performance in academic and work environments. For example, young adults in college regulate their learning behavior with a variety of specific strategies (Pintrich, 1994). They manage their own time, decide with whom to study, and monitor their comprehension with a variety of internal (self-regulation, strategies) and external (peers, family, faculty) supports.

In addition, several studies have shown that metacognition is not a set of idiosyncratic behaviors but a finite set of common skills that are highly correlated to academic success (Garcia & Pintrich, 1994; Pintrich, 1994). Reis, McGuire, and New (2000) described qualitative patterns focusing mainly on motivational aspects in support of the hypothesis that metacognition plays a major role in the success of students with LD. Recent research on college students with LD suggests that metacognition (e.g., self-regulated behavior) is a strong predictor of academic success (Ruban, 2000; Smitely, 2001).

In explaining the compensatory role of metacognition in the academic achievement of students with LD, an analogy may be drawn to research on the relationship between metacognition and cognitive deficits in the literature on aging. While older adults face diminishing cognitive abilities and reduction in efficiency (Salthouse, 1992), some fare much better than others for a longer time (Dixon & Baeckman, 1995). Baltes and Baltes (1990) suggested three possible paths to compensating for lost cognitive abilities. One such path is *metacognitive control*, defined as strategies, effort, and self-regulation of activities. This path must be under the direct control of the individual. That is, the person faced with a task related to a deficit must decide to use a strategy to compensate while weighing costs and benefits. This includes strategies related to the individual's actions (e.g., making lists to compensate for memory deficit), as well as strategies that include technological supports and help seeking. Another path, *cognitive compensation*, implies that individuals who face a deficit in

one cognitive domain may use relative strengths from another cognitive domain such as general processing, working memory, or semantic ability that can assist performance. Finally, Dixon and Baeckman (1995) offer a third option, *lowering of standards*. Here, the individual chooses an alternative approach that reduces the demands on the deficient process; for example, writing shorter sentences to reduce working memory load (Kemper, 1986).

In this study we considered whether successful students with LD rely on metacognitive strategies to compensate for processing difficulties. We also considered the deficient cognitive processes that metacognition may compensate for. The literature suggests that students with LD in most cases have deficits in phonological processing. For example, comparing the phonological processing of adult LD with age-and-reading-level matched groups, Bruck (1992) found that adults with childhood diagnoses of LD functioned far below the norm for both their age and reading level. Similarly, Scarborough (1984) reported that adults with a childhood history of dyslexia performed poorly on non-word spelling tasks, confirming the persistence of phonological encoding difficulties. A study by Pennington and his colleagues (1986) also revealed a deficit in phonological processing in adults with LD, while showing normative performance in their ability to spell morphologically complex patterns. In a subsequent study, Lefly and Pennington (1991) found that the same pattern of low phonology in adults with LD was compensated for by spelling. Although not age-appropriate, spelling of morphologically complex words was better than phonological spellings.

Considerable evidence shows that the word reading ability of adults with LD is consistently lower than that of their nondisabled peers (Apthorp, 1995; Bruck, 1990; Ritter, 2000). While the reading comprehension of college students with LD was considerably lower than that of their NLD peers, it was still considerably higher than that of decoding level-matched (hence younger) participants (Bruck, 1985, 1990; Ransby & Swanson, 2003). Furthermore, comprehension of both reading and listening has been shown to be orthogonal to reading fluency and word reading ability in LD students (Ransby & Swanson, 2003). This finding suggests that college students with LD may rely on different cognitive processes (e.g., processes related to listening comprehension rather than phonological decoding) in their path to reading comprehension compared to their NLD peers.

In summary, the purpose of this study was to explore whether college students identified with LD use metacognitive strategies to compensate for their phonological processing deficits. Two student groups (LD vs. NLD)

were compared to determine those processes that are similar and those that are different between the two groups. We hypothesized that college students with disabilities compensate in cognitive processing by relying on metacognitive strategies. We also explored whether such students rely on strengths in other cognitive processes in addition to metacognition that allow them to compensate for difficulties in phonological processing.

METHOD

Participants

Participants were 40 students (20 LD, 20 without LD) from four universities in Southern California. Students with LD volunteered for the study after a letter soliciting their participation was sent by the disability centers in the respective universities. Students without LD (referred to as NLD) were matched as closely as possible to the population of students with LD on demographic variables of ethnicity, college major, gender, and academic standing (i.e., grades). Participants' chronological age ranged from 18 to 64 years. The NLD group had a mean age of 21.75 ($SD=1.12$), while the group with LD had a mean age of 31.4 ($SD=13.56$). The LD group consisted of 15 women and 5 men. The control group (NLD) consisted of 16 women and 4 men.

Overall ethnic composition was 40% White non-Hispanic, 20% Hispanic, 12.5% African American, 22.5% Asian American, and 5% other or mixed ethnicities. The distribution of ethnicity in the two groups was not significantly different, $\chi^2(4)=3.95, p=.41$. Class standing in the LD and NLD groups was similar, as illustrated in Table 1. Further, there was no difference between the distributions of major fields of study between the groups.

Participants' socioeconomic status was measured by parental education. The NLD group had a higher level of parental education, $M=5.53$ ($SD=1.29$) (5=some post-secondary education and 6=undergraduate degree), compared to students with LD ($M=4.22$ ($SD=2.15$)). The difference was statistically significant $t(38)=2.32, p=.027, d=.73$. Most of the difference between the LD and NLD groups may be attributed to four participants (20%) in the LD group who came from immigrant families and whose parents had either an elementary education or no formal education at all. The observed difference corresponds to the data on young adults with disabilities presented by Wagner and her colleagues (1993).

Selection

Students with LD were recruited with cooperation from the university disability centers at participating

Table 1
Class Standing and Major Field of Study for LD and NLD Samples

Class Standing	NLD	LD	Total
Freshman	1	4	5
Sophomore	2	1	3
Junior	5	3	8
Senior	11	10	21
MA	1	2	3
Major			
Humanities	7	7	14
Social Science	7	8	15
Science	6	5	11

Note. Class standing, $\chi^2(4)=3.01, p=.56$. Major, $\chi^2(2)=.16, p=.92$.

Table 2
Means and SD of Learning Disability Indicators by Group

	NLD	LD	Comparison
Word Attack (WRMT)	106.7 (9.1)	84.8 (6.8)	NLD>LD***
Digit Naming Speed (CTOP)	104.5 (13.1)	89.2 (16.4)	NLD>LD**
NonVerbal Intelligence (Raven PM)	110.2 (10.1)	98.8 (7.2)	NLD>LD**

Note. Standardized score: $M=100$; $SD=15$; ** $p<.01$; *** $p<.005$.

institutions. The participants with LD had been either diagnosed or had their diagnosis confirmed in adulthood by trained professionals. Further, the LD diagnosis was confirmed by experimental measures in this study. To be considered LD a participant had to satisfy two conditions on standardized measures: (a) low phonological processing (< 25th percentile) and (b) average range of intelligence (IQ > 84). All the students who were previously identified as having LD satisfied both conditions. Descriptive statistics for both groups are shown in Table 2. Success in college was defined as an acceptable range of GPA (2.0 or above). Relative achievement was measured by grade point average.

Several measures were administered both to students with and without LD. The achievement, process, and metacognitive measures were selected due to their strong theoretical basis and robust validity and reliability in published studies. All experimental measures had acceptable internal consistency reliability alpha ranges, .78-.98.

CLASSIFICATION MEASURES

Grade Point Average

Each student provided his or her current grade point average as it appeared in his or her transcripts at the time of the study. GPA ranges were 2.0-3.8, on a 4-point scale. GPA was selected as a measure of college success because it reflects adaptation to the college learning environment. We assumed that the additive nature of GPA measures success in specific courses as well as adaptation to the overall requirements associated with college, in addition to the ability to find a fit between individuals and their chosen academic path. GPA can be influenced extensively by metacognitive strategies, self-regulation, and motivational strategies (Garcia &

Pintrich, 1993), mainly because it allows the execution and constant improvement of strategies.

Phonological Processing

Word attack. The Word Attack subtest of the Woodcock Reading Mastery Test (Woodcock, 1987) assessed participants' phonological decoding, independent of semantics or comprehension, through a series of pseudo-words.

Phonological processing. Two subtests of the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1998) were used: Sight Word Efficiency and Phonemic Decoding Efficiency. The efficiency score measured the rate of as well as participants' ability to engage successfully with text under time constraints. Specifically, the Sight Word Efficiency subtest assessed the number of real printed words participants accurately identified within 45 seconds. The Phonemic Decoding Efficiency subtest measured the number of pronounceable printed pseudo-words that were accurately decoded within 45 seconds.

COMPARISON MEASURES

Working Memory

Phrase sequence. This subtest of the Swanson Cognitive Processing Test (S-CPT; Swanson, 1995) measured the verbal working memory capacity/efficiency of participants. Before recall, participants were asked a process question to interfere with short-term memory. It required participants to recall an increasing sequence of independent phrases.

Story retelling. This subtest of the S-CPT (Swanson, 1995) measured working memory for connected text. The test requires participants to recall a series of episodes in a paragraph in their original order after answering a process question.

Sentence span measure. This test measures verbal working memory. It was originally used by Daneman and Carpenter (1980) and adapted by Swanson, Cochran, and Ewers (1989). Participants were asked to attend to sentences read by the examiner. After listening to the sentences, participants answered a process question based on the sentences and were then asked to recall the last word in each sentence in correct order. While the stop rule of the original test was retained, scoring was altered to add reliability and discrimination. Under the altered scoring rule, each sequence recalled correctly was awarded 1 point.

Speed of processing. Rapid automatic naming (RAN) is a measure of processing speed that has been hypothesized to be a deficit in reading disabilities (Wolf & Bowers, 1999). In this study, RAN was measured by timed letter recognition and digit recognition subtests of the Comprehensive Test of Phonological Processing (CTTOP; Wagner, Torgesen, & Rashotte, 1999).

Short-term memory. The Digit Span subtest of the Wechsler Adult Intelligence Scale–Revised (WAIS-R; Wechsler, 1981) was used to assess short-term verbal memory. In the digits-forwards segment participants were asked to repeat a series of numbers presented verbally one per second. In the digit-backwards section of the subtest, participants were asked to repeat the digits in reverse order.

Olson Orthographic Test. This test measures the efficiency of letter and digit recognition by measuring visual recognition of patterns that occurred before phonological processing. In this time-limited test (30 s.), participants were asked to match a letter/number pattern from a column on the left to one of four options on the right.

Semantic Processing

Word classes. This subtest of the Clinical Evaluation Language Fundamentals-3 (CELF-3; The Psychological Corporation, 1994) assessed participants' ability to make semantic associations. A series of 3-4 words are presented orally once. Participants are then asked to repeat the words that go together best.

Semantic fluency. In this test (Harrison, Buxton, Husain, & Wise, 2000), participants were asked to recall as many animals as they could in 90 seconds. This experimental measure assessed participants' ability to make connections based on existing knowledge. While specialized knowledge might play a role in some cases (e.g., zoo keepers, park rangers, zoologists), using animals as a common category should present no knowledge limitations under the time constraints of the test. Participants were instructed not to repeat or use plural forms of an animal name. The dependent measure was the total number of correct names.

Vocabulary. Vocabulary was assessed using the Peabody Picture Vocabulary Test–Revised (PPVT-R; Dunn & Dunn, 1981).

Spatial reasoning. The Raven's Advanced Progressive Matrices Test (Raven, 1986) is a general reasoning test assumed to measure nonverbal intelligence. Participants identified a partial figure for a series of other partial figures that complete a given matrix. The patterns increase in difficulty as the test progresses.

Reading

Word identification. This subtest of the Woodcock Reading Mastery Test–Revised (Woodcock, 1980) required participants to read isolated words. Words presented to the participant became more complex phonologically and orthographically.

Table 3
Observed Means, Standard Errors, Comparisons, and Effect Sizes of Achievement Measures

	NLD (<i>n</i> =20)		LD (<i>n</i> =20)		Comparison	ES <i>D</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
GPA	2.88	.37	2.83	.58	NLD=LD	0.16
Reading Comprehension-WRMT	104.7	7.7	104.7	12.1	NLD=LD	0.01
Vocabulary-PPVT	102.8	8.3	98.6	12.1	NLD=LD	0.40

Note. GPA is on 4-point scale. Reading comprehension and PPVT scores are standard scores: *M*=100; *SD*=15. **p*<.05.

Table 4***Means, Standard Deviations, Least-Square Means, and Effect Sizes of Cognitive Tasks***

	<i>M (SD)</i>		<i>LSM</i>	
	<i>NLD</i>	<i>LD</i>	<i>NLD</i>	<i>LD</i>
Sentence Span	5.3 (1.8)	4.1 (1.5)	102.3	97.6
Phrase Sequence	2.2 (1.1)	1.5 (1.2)	104.4	95.6
Story Retell	5.9 (2.2)	6.25 (2.3)	98.6	101.3
Sentence Span	5.3 (1.8)	4.1 (1.5)	102.3	97.6
Phrase Sequence	2.2 (1.1)	1.5 (1.2)	104.4	95.6
Story Retell	5.9 (2.2)	6.25 (2.3)	98.6	101.3
Semantic Recall	29.4 (6.0)	26.8 (7.5)	102.7	97.3
CELF Word Classes	17.4 (1.4)	15.5 (3.0)	105.7	94.3
RAN Letters ^a	24.4 (3.8)	29.5 (6.9)	104.5	89.3
RAN Digits ^a	22.3 (4.8)	28.8 (8.5)	99.75	88.4
Digit Span	18.6 (4.5)	14.7 (2.7)	107.0	93.0
Word Attack	38.9 (2.5)	29.6 (4.2)	106.7	84.9
Word ID	99.3 (2.4)	91.7 (8.9)	102.9	89.1
Decoding Efficiency	56.5 (5.4)	35.6 (12.2)	111.1	88.9
Sight Word Efficiency	98.3 (3.9)	79.4 (11.1)	111.1	88.9
Olson	12.7 (2.4)	8.9 (3.3)	105.9	94.1
Raven	17.7 (3.9)	13.2 (6.8)	107.6	101.4

Note. Least-square means are in standardized form, $M=100$; $SD=15$, adjusted for covariates when applicable. ^a This metric is time in seconds, inverting the relationship between LD and NLD students.

Reading comprehension. The Passage Comprehension subtest of the Woodcock Reading Mastery Test (Woodcock, 1987) measured participants' ability to understand a passage by requiring them to complete a cloze exercise by coming up with a word that agreed with the syntactic structure, the context, and specific content of the given passage.

Metacognition

Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1993). The MSLQ is a self-report, 7-point rating scale designed to assess motivational strategies and use of learning strategies by college students. The motivation scales measure three broad areas: (a) value (intrinsic and

extrinsic goal orientation, task value); (b) expectancy (control beliefs about learning, self-efficacy); and (c) affect (test anxiety). The learning strategies section is composed of nine scales that can be distinguished as cognitive, metacognitive, and resource management strategies.

RESULTS

The means and standard deviations for all measures are shown by category in Tables 3-5. The first analysis examined achievement differences between students with LD and those without LD. The second analysis focused on differences between the groups in cognitive and metacognitive measures, using a multivariate analysis of variance (MANOVA). The final analysis focused on compensatory mechanisms by comparing the effects of strategy use for students with and without

LD. Because age differences emerged between the groups, age was used as a covariate in subsequent analyses. Univariate analyses were not conducted to minimize type I error rates.

Achievement

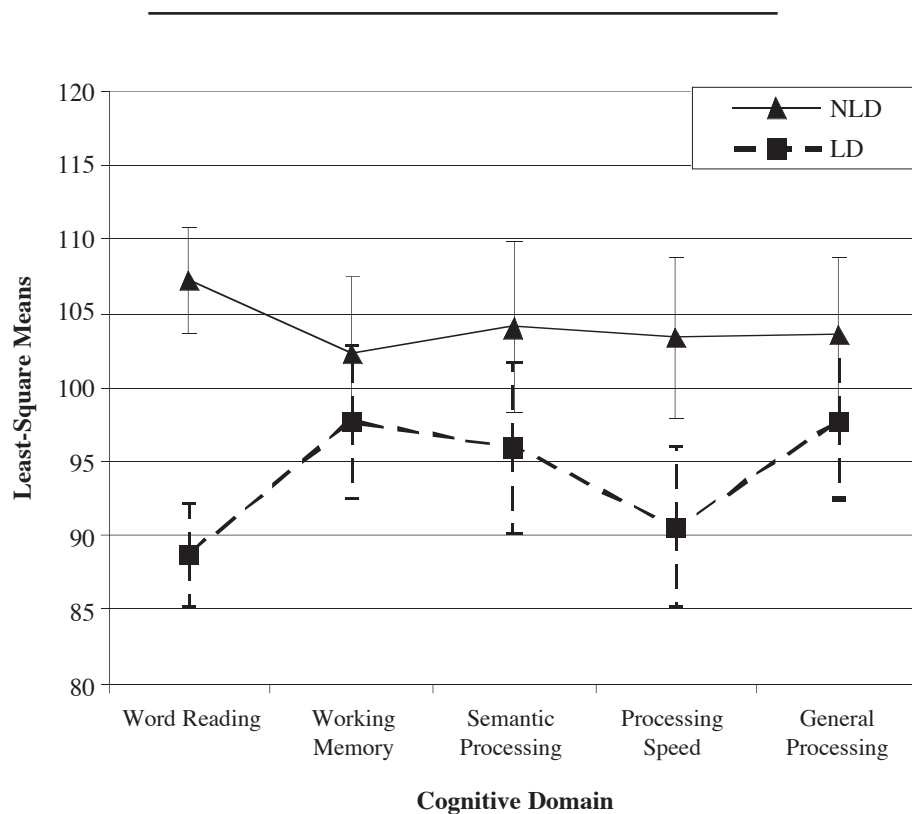
The descriptive statistics in Table 3 show the results from achievement measures. A MANOVA on achievement measures failed to reveal a significant difference, $F(3,36)=.67, p>.05$.

Cognitive Measures

The cognitive measures were analyzed in each of the five clusters: word reading, working memory, semantic processing, processing speed, and general processing.

Word reading. A MANOVA was conducted with disability status (LD vs. NLD) as the fixed factors and all four word-reading tasks (Word Attack, Word Identification, Decoding Efficiency, and Sight Word Effi-

Figure 1. Cognitive profile of students with LD & NLD. Least-square means and confidence intervals, controlling for age.



ciency) as outcomes. The overall effect was significant, $F(4,35)=31.28, p<.001, \text{Wilks}' \Lambda=.22$.

Working memory. Results of the MANCOVA were not significant for ability group, $F(3,35)=.73, p=.54, \text{Wilks}' \Lambda=.94$.

Semantic processing. The overall MANCOVA for disability status (LD vs. NLD) was significant for the two semantic processing tasks, $F(1,37)=3.29, p=.05, \text{Wilks}' \Lambda=.85$.

Speed of processing. The MANCOVA was significant for the group effect, $F(3,36)=9.67, p<.0001, \text{Wilks}' \Lambda=.55$. As illustrated in Table 4, students with LD were slower in all the tasks associated with processing speed.

General processing. The results of the Raven were examined using an ANCOVA. The difference between students with and without LD was not significant, $F(1,38)=1.6, p>.05$.

Cognitive Performance

Composite scores were created from standardized scores ($M=100; SD=15$) in each cognitive domain: word level reading, working memory, semantic processing, and speed of processing. Reliability of the composites was .90 for word level reading, .75 for working memory, .60 for semantic processing, and .83 for speed of processing. The profiles in Figure 1 show significant difference in all domains except for the composite working memory score. This finding occurred because both groups were comparable in reading comprehension. That is, reported correlations between reading comprehension and working memory were high (r 's in .80 range; see Daneman & Carpenter, 1980). Overall, however, the cognitive functioning on most domains associated with reading was lower for students with LD.

Metacognitive Measures

Motivation. A MANCOVA was conducted to estimate a possible difference in motivation between students with LD and NLD in four motivational subtests of the MSLQ: internal goals, external goals, task value, and control. Results showed a nonsignificant main effect for disability status, $F(3,36)=.94, p=.43, \text{Wilks}' \Lambda=.93$.

Expectancy components. High self-efficacy and high perceived control were positive indicators of metacognition. That is, a high score on these measures corresponded to a high sense of self-efficacy and control. The third factor in this analysis was test anxiety. Here a high score indicated high anxiety, which corresponded to lower self-efficacy and a low sense of control. For this analysis, test anxiety scores were inverted to indicate low anxiety with a high score and high anxiety with a low score.

Because the overall analysis showed that age was not a significant covariate, a MANOVA was computed on

three expectancy values. A significant group effect emerged, $F(3,36)=4.97, p=.005, \text{Wilks}' \Lambda=.71$. Results indicated an overall lower expectancy value for students with LD compared with NLD students. The results of the univariate analyses (see Table 5) showed that perceived control and test anxiety were lower for students with LD. Self-efficacy for both students with LD and NLD were statistically comparable.

Learning strategies. A MANCOVA on the MSLQ learning strategies (rehearsal, critical thinking, organization, and elaboration) was computed. Disability status was nonsignificant, $F(4,34)=1.10, p=.39, \text{Wilks}' \Lambda=.89$.

Self-regulation of learning. A MANCOVA was conducted on the five self-regulation subtests of the MSLQ (manage resources, manage time and resources, effort regulation, peer learning, and help seeking). A significant group effect was found, $F(5,33)=2.67, p=.04, \text{Wilks}' \Lambda=.71$. The overall test indicated a significant higher use of self-regulation by students with LD than NLD students.

In summary, results of the above analyses showed that students with LD were not statistically different from NLD students in terms of motivation, metacognitive strategies, and reading strategies. However, they were higher in number of hours of study and overall self-regulation compared to NLD students. In addition, students with LD had significantly lower expectancy than NLD students.

The Relationship Between Metacognition and Achievement

Although differences in learning strategies between groups were not detected, an important question was whether strategy use was related to achievement for the LD group alone. Because the correlation between strategy use and GPA for the LD group was significant, $r=.57, p=.006$, further analysis was necessary to examine strategy use.

Compensation through metacognitive strategies. All students were divided into groups of low and high strategy use based on the MSLQ combined score for strategy. In the NLD group, 11 students had low strategy use and 9 had high strategy use. For the students with LD, 11 fell in the high-strategy use group and 9 in the low-strategy use group. The age covariate was not significant; therefore an ANOVA was computed.

The results indicated that strategy use yielded a significant main effect, $F(1,36)=6.53, p<.05, \text{MSE}=.19$. This finding indicated that high strategy use was associated with higher GPA. More important was the interaction Disability Status x Strategy Use, $F(1,36)=5.63, p<.05, \text{MSE}=.19$. Students with LD with high strategy use had higher achievement than that of NLD students.

Table 5***Means, Standard Deviations, and Least-Square Means of MSLQ Subscale***

	<i>M (SD)</i>		<i>LSM</i>	
	<i>NLD</i>	<i>LD</i>	<i>NLD</i>	<i>LD</i>
Intrinsic Goal Orientation ^a	19.1 (2.5)	20.7 (5.4)	100.6	99.4
Extrinsic Goal Orientation	22.0 (3.6)	20.4 (4.3)	102.9	97.0
Task Value ^a	32.2 (3.8)	32.3 (5.4)	103.6	96.4
Perceived Control	19.7 (4.6)	19.3 (.81)	104.6	95.4
Self-Efficacy	29.6 (4.8)	30.6 (1.2)	101.2	98.8
Test Anxiety	17.4 (4.5)	15.8 (1.0)	105.7	94.3
Rehearsala	19.7 (4.6)	19.3 (.81)	103.6	96.4
Elaborationa	29.6 (4.8)	30.6 (1.2)	102.3	97.7
Organizationa	17.4 (4.5)	15.8 (1.0)	105.1	94.8
Critical Thinking ^a	18.8 (5.2)	21.1 (1.5)	99.9	100.1
Manage Resource ^a	49.3 (7.5)	54 (1.96)	99.1	100.9
Manage Time/ Study ^a	35.7 (9.1)	41 (1.91)	98.4	101.6
Effort Regulation ^a	18.6 (4.1)	19 (1.24)	97.1	102.8
Peer Learning	11.2 (3.5)	12.0 (.57)	97.9	102.1
Help-Seeking	17.2 (4.3)	19.0 (.64)	96.4	103.5

Note. Least-square means are in standardized form, $M=100$; $SD=15$, adjusted for covariates when applicable. ^a This metric is time in seconds, inverting the relationship between LD and NLD students.

Help seeking. A number of studies have pointed to help seeking as a key strategy in regulating learning (e.g., Branker, 1997; Merladet, 2001; Ruban, 2000). In this analysis the age covariate was not significant. An ANOVA indicated a main effect for help seeking, $F(1,36)=7.50$, $p<.01$, $MSE=.18$, and an interaction between disability status and help seeking, $F(1,36)=5.61$, $p<.05$, $MSE=.18$. The interaction indicated that that help seeking was not associated with increased achievement for NLD students but was highly associated with achievement for students with LD.

DISCUSSION

This study assessed whether college students with LD who have a phonological deficit compensate for their processing difficulties by relying on increasing levels of metacognition. Grade point average and achieve-

ment were found to be related to increased metacognitive learning strategies and help-seeking activities in students with LD.

The results point to four additional areas of importance. First, students with and without LD performed equally well across the three achievement measures used: GPA, reading comprehension, and vocabulary. The nonsignificant difference in achievement between the students with LD and their NLD peers corroborated Vogel and Adelman's (1992) and Wilczeki's (1993) findings, showing that achievement levels for college students with LD in their junior and senior years were equal to those of their NLD peers.

Second, college students with LD in this study were still suffering from significant difficulties in basic processes connected with reading. Thus, deficits were present in all aspects of their word reading, pseudo-

word reading, real-word reading, and rate of reading, even though reading comprehension was in the average range. In addition, speed of processing results were similar to the results of the phonological processing and word-level reading in general. These ongoing difficulties support Bruck's (1990, 1992, 1993) findings of continuing phonological deficits in individuals with a childhood diagnosis of dyslexia. Students with disabilities performed lower in the two hypothesized deficits connected with LD, word reading ($d=3.8$) and speed of processing ($d=1.77$). However, phonological and speed of processing were not the only cognitive domains in which students with disabilities performed significantly lower than their peers without LD. They also performed lower in semantic processing and short-term memory.

These significant differences across the four domains support a view of a more generalized deficit than only phonology in students with LD. Thus, the results highlight the difficulty in naming one or two specific deficit processes when defining LD when both groups are comparable in reading comprehension.

Third, the motivation of students with LD was comparable to that of their NLD peers. Their self-assessment extrinsic and intrinsic motivations were the same. However, these findings were qualified when the analysis focused on anxiety, help seeking, and self-regulation.

Finally, the students with LD had a significantly lower expectancy value and high anxiety, similar to the findings reported by Stevens (2001). A possible explanation is protective pessimism (Cantor & Norem, 1989; Norem & Cantor 1986). According to Cantor, some individuals motivate themselves to work harder and protect themselves from possible failure by being a priori and unrealistically pessimistic about their prospects. The pessimistic view of future achievement promotes self-regulation of task attainment; it promotes planning, thought, and effort. While defensive pessimism is beneficial in the short run, possible negative outcomes relate to self-image, long-term satisfaction, and stress levels (Cantor, 1989).

Test anxiety had a very different impact for students with and without LD. Specifically, students with LD have a long history of difficulty and failure. Thus, adverse physical and psychological reaction to a testing situation is more a result of past experiences than a disproportional reaction. Results indicate that for students with LD, normal test anxiety is not associated with actual performance, but serve as protective pessimism.

Students with LD reported seeking help more often than their NLD peers. They made conscious attempts to recruit family, friends, instructors, and formal agencies to support their learning. In self-regulation of learning and time management, students with LD had more con-

sistent and varied use. Students with LD spent considerably longer hours on schoolwork than their NLD peers, most over 30 hours a week. In surveys students with LD reported starting to prepare early, avoiding last-minute learning (cramming), and, in some cases, adopting a pre-exam ritual.

Do successful students in college rely on metacognition to compensate for weak reading skills? A direct answer to this question cannot be given. This is because students with LD indicated using the same level of problem solving as their NLD peers during academic reading, after accounting for age differences. Students with LD were not more strategic than their NLD peers about preparation for tests, in lessons, and in writing papers. Further, the use of strategies in learning and reading to predict grade point average was not significantly different between student with LD and NLD.

However, differences in metacognitive performance levels in self-regulation of learning and expectancy levels indicate a possible compensatory route for students with LD. Results supported the hypothesis that students with LD benefit more from high strategy use than NLD students. Students with LD who were strategic about their learning had as high a grade point average as NLD students who were strategic and significantly higher achievement than students who were low strategy users regardless of disability status. Students with LD and low strategy use, on the other hand, had a grade point average lower than all other groups, showing that strategy use is a key to the success of students with LD.

The study also showed a similar pattern in help seeking. That is, students with LD and low help-seeking ability had much lower grade point averages than all other groups. At the same time the help-seeking level for students without LD did not relate to GPA level.

Because compensation was observable in the achievement level of students with LD, the question about the possible paths to academic success despite deficiencies remains unanswered. In their theoretical model of life span compensation, Baltes and Baltes (1990) suggested two nonmutually exclusive paths: cognitive and metacognitive. Cognitive compensation stipulates that adults with lower processing ability (older individuals in Baltes & Baltes, 1990; students with LD in the present case) use more efficient processes or general processing ability (e.g., working memory) to compensate for their difficulties whenever possible. The model offered by Baltes and Baltes (1990) is a general model of compensation. To operationalize cognitive compensation related to reading, there is a need for a model describing the processes related to reading and the interactions involved with them. More specific models of reading suggested by Perfetti (1988) and Connors and Olson (1990) suggest that in order to compensate for difficul-

ties in word reading, individuals with LD have to rely on vocabulary knowledge and working memory. The analyses of variance in the present study showed a pattern of results compatible with the models suggested by Perfetti and Conners and Olson.

Implications

The results have implications for both the transition of students with LD into postsecondary education and the support they receive there. Transition should emphasize the realities of college life, as one student with LD in this study put it, "It's not like high school. Most classes are so big nobody cares about you; they do not even know who you are. Nobody will say anything until they are ready to kick you out." Entering higher education shifts the burden of social ecologies from established networks of family and school to the individual. It may be beneficial for some students to start at the junior college level with added support and then get into the more demanding and less supportive four-year colleges. Help-seeking and social skills are integral to establishing the support systems crucial to academic success. Time management skills and decision making about resources are also important and should be part of the transition into higher education as well as an ongoing evaluation of progress. Constantly redefining the learning strategies in reading, test taking, and writing that work for the individual is important in establishing long-term success. Finally, it is important to emphasize, for both students and educators, that strategies are general principles adjusted to fit specific demands and content, not a set of always-applicable skills.

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- Requests for reprints should be addressed to: Guy Trainin, 118 Henzlik Hall, University of Nebraska, Lincoln, NE 68588; gtrainin@unl.edu.