A LONGITUDINAL EXAMINATION OF THE REMEDIATION OF LEARNING DISABILITIES:
IQ, AGE AT DIAGNOSIS, SCHOOL SES AND VOLUNTARY TRANSFER

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This three year longitudinal study examined the effects of IQ, age of diagnosis, school socioeconomic status (SES) and participation in desegregation programs on the remediation of learning disabilities. Participants included 176 children who were diagnosed with a learning disability, 44 of whom were participants in a voluntary transfer program. Baseline discrepancies between standardized cognitive and achievement scores were obtained at the time of the initial learning disability diagnosis. The effect of remediation was measured at a three-year re-evaluation period. Results indicated that IQ and age at diagnosis were significant predictors of remedial success, while school SES and transfer status were not. Students with higher IQ scores, who were identified at an earlier age, showed greater remedial gains. The results underscore the importance of early identification and suggest more intensive services and follow-up be given to children with lower IQ.

The remediation of learning disabilities (LD) is a large scale, national undertaking aimed at improving the educational opportunities of millions of children. Identifying factors associated with remediation outcome, then, is of utmost importance. Most research examining this issue consists of controlled studies of specific treatments, conducted within a single school or district, with children who reside in the district, and outcomes are assessed after a relatively a short period of time. This study, in contrast, examined the role of individual factors, school district resources, and student transfer status in a three year longitudinal follow-up, and remediation outcome was assessed within the real world context of the children's school.

Children with learning disabilities are an at-risk population; they are more likely to experience lower self-esteem, make fewer friends, and are one and one half times more likely to drop out of school than non-disabled children, and adults with LD are more apt to experience unemployment difficulties (American Psychiatric Association, 2000). Not all individuals with learning disabilities, however, suffer such adverse outcomes, as some graduate from high school and college and establish successful careers (Osborne, Schulte & McKinney, 1991; Raskind et al., 1999). The magnitude of the efforts, the enormity of the expense, and the potential impact on individuals' future has prompted considerable research examining the factors related to treatment of LD (Swanson, Hoskyn & Lee, 1999). Despite these efforts, gaps remain in our understanding.

One important factor that may be related to remediation, which has been relatively overlooked until recently, is IQ-intelligence. Research with non-LD children has consistently demonstrated IQ to strongly predict academic performance, school success and occupational status (Gofffredson, 2002; McCall, 1977; Schmidt & Hunter, 2004; Sternberg, Grigorenko & Bundy, 2001). As IQ is closely associated with school-related skills and activities, it would be expected that for children with LD, higher IQ would be associated with greater gains from remediation. Indeed, research across differing types of interventions, from preschool to grade school, supports this conclusion (Beringer, et al., 1999; Foorman, et al., 1998; Hatcher & Hulme, 1999; O'Connor et al., 1993; Torgensen et al., 2001; Wise, Ring & Olson, 1999). The evidence, however, is not universal, as some studies have failed to find a relation (O'Shaughnessy & Swanson, 2000; Schneider et al., 1999; Vadasy et al., 1997; Vellutino, Scanlon & Lyon, 2000). Fuchs and Young (2006) suggest the reason for this discrepancy is that the studies reporting negative findings involved younger children and did not use standardized IQ tests.

Generalization from this body of research, however, requires caution. Almost all the studies examined interventions that lasted weeks or months, not the prolonged exposure typical for children with learning disabilities. Furthermore, interventions were conducted within a single school or school district and usually closely monitored. While this allows for tighter experimental control, it is unclear whether the conclusions apply to large scale, real world school contexts, across multiple school districts. Examination of multiple school districts across a longer intervention time span would augment and inform existing research. Such efforts, however, are not only difficult to conduct, but these less controlled settings introduce considerable error variance. Nevertheless, these limitations should not deter trying, for they may detect a *signal amidst the noise* that affords greater confidence in generalizing to real world contexts.

Although IQ may be a potentially valuable predictor of treatment outcome for LD, it is also entangled in fundamental debates about its utility for defining and treating LD. LD has been defined as a discrepancy in IQ-achievement scores, but many consider the conceptual distinction between IQ and achievement to be problematic and, thus, so too, the validity of LD based on a discrepancy (Fletcher, et al., 2002; Siegel, 1989; 1999). Furthermore, many now advocate for a definition of LD tied to response-to-intervention (RTI), not IQ-discrepancy scores (Grimes, 2002; Lyon et al., 2001; Fuchs, Fuchs & Compton, 2004). However, despite these telling and controversial critiques, DSM IV, as well as many states and school districts, continue to use the IQ discrepancy model for placement and treatment. The question of whether IQ is related to treatment outcome, then, still has important practical utility.

Age at time of diagnosis is another variable that may be related to remediation of LD. For many childhood disorders, early detection and treatment are critical for improving the course and outcome of children's lives (Ramey & Ramey, 1998). This may also apply to LD (Lyon 1996). Research by Francis et al. (1996) indicates that rates of reading improvement for eight year old students with LD was greater than non learning disabled students, while a plateau in reading abilities among both groups was reached by 15 years of age. This suggests there may be a sensitive period for maximal remedial gains. Younger children would, thus, be expected to benefit more from intervention. Few studies, however, have directly examined the relation between age and treatment effects, a significant oversight with important practical implications.

Socioeconomic status (SES) is another potential variable that may influence treatment outcomes for LD students. Lower SES is associated with higher rates of LD (Barona & Fayku, 1992), and those from lower SES environments also experience more negative consequences than high SES individuals, including lower high school and college graduation rates and greater unemployment (O'Connor & Spreen, 1998). While this provides evidence for the differential effects of SES on students' with LD subsequent academic success, the results may be due to greater opportunities, social support or other factors related to SES, not the remediation of LD.

SES is typically measured via individual family economic parameters, such as household income, parental education, and occupation. When viewed from a broader sociological perspective, school SES may provide important assessment of educational resources. Schools are the point of contact between child and remediation interventions, and children spend much of their in this setting. Furthermore, low SES schools have been found to have fewer materials and resources (Cooper & Speece, 1990; Esposito, 1999; Reynolds, 1991), and the general literature indicates that high SES schools are positively correlated with academic achievement (Greenwood, et al., 1994). The effects of school SES on the remediation of LD remains to be investigated.

The SES of neighborhood schools is frequently equivalent to the SES of the resident population. Not all school placements, however, are as clear-cut. Each year, thousands of students participate in desegregation programs where children, often from lower income neighborhoods, are transferred to different school environments. Research indicates that transfer students attending higher SES schools demonstrate greater academic gains (Kaufman & Rosenbaum, 1992; Longshore & Prager, 1985; McIntire et al., 1982; Thrup, 1997). No research, however, has addressed whether remediation efforts for children with LD are as effective for transfer students as their nontransfer peers, or whether school SES differentially effects remediation for transfer LD students. Transfer students must cope with stresses that nontransfer students do not have to face, so remediation may be less effective for them. Additionally, students transferred to higher SES schools would presumably benefit from the enriched

environment and therefore demonstrate greater remediation than those transferred to lower SES schools.

This study examined the remediation of LD in resident and voluntary transfer students from 18 school districts of varying SES in a large midwestern metropolitan area. Students in all these districts are under the administrative umbrella of a single, Special School District that is responsible for the staff, policies and procedures concerning handicapped and disabled students. Thus, while the school districts varied in SES, the assessment and treatment of all LD students was organized and administered by the Special School District, ensuring uniformity and continuity across a large and diverse population. Students were assessed when they were first diagnosed and placed in a remediation program and then reassessed three years later. It was hypothesized that higher IQ, earlier age of diagnosis, higher school SES, and nontransfer status would be related to greater remediation. It was also hypothesized that transfer students in higher SES schools would evince greater gains than those in lower SES placements.

Method
Participants
Participants were 176 children who were diagnosed with a learning disability between 1984 and 2000. The group consisted of 111 males and 65 females, of which 110 were Caucasian and 66 were African American with a mean age of 9.5 years (SD = 2.6) at the time of initial diagnosis. The non-transfer group consisted of 132 children who were educated in their resident neighborhood public schools. This group included 82 males and 50 females; 107 were Caucasian and 25 were African American (see Table 1). The transfer group included 44 children who participated in a state voluntary transfer program and consisted of 29 males and 15 females, all of whom were African American. All students attended schools from 18 school districts that are within the umbrella of a countywide Special School District, which is responsible for identifying and providing educational services for all handicapped and disabled students.

Table 1
Participant Demographics

Variable	Transfer Group n=44	Non-transfer Group n=132	Total n=17
African-American	44 (100%)	25 (19%)	69 (39%)
Caucasian	0	107 (81%)	107 (61%)
Female	15 (34%)	50 (38%)	65 (37%)
Male	29 (66%)	82 (62%)	111 (63%)
Age at Time 1			
Mean	10.2	9.3	9.5
SD	2.6	2.5	2.6

Several criteria were used to determine participant eligibility in the study. Each qualified student had a learning disability that was initially diagnosed (Time 1) between 1984 and 2000 according to the state guidelines that defined LD using IQ-discrepancy criteria. Students also needed to have had a comprehensive re-evaluation (Time 2) three years from the time of their initial diagnosis. The re-evaluation included the use of a standardized cognitive test and the same achievement test that was given at the initial diagnostic evaluation. To adequately assess the effect of school SES on remediation, the student also had to have received special education services within the same school district from Time 1 to Time 2.

Measures
Cognitive measures
General cognitive functioning was assessed through the following standardized measures: WISC-R (Wechsler, 1974), WISC-III (Wechsler, 1991), WAIS-R (Wechsler, 1981), Stanford-Binet Fourth Edition (Thorndike, Hagen & Sattler, 1986), K-ABC (Kaufman & Kaufman, 1983), and K-BIT (Kaufman & Kaufman, 1990). Each of these measures is well normed and validated, and was commonly used in the practice of assessing intellectual ability between 1984 and 2000. While each of the above-mentioned cognitive measures has a mean score of 100, differences do exist between the tests' standard deviations. Thus, all test scores were converted to standard *z*-scores, allowing for interchangeable use and comparison between tests.

In the present study, intellectual functioning was measured for each student through one of the above-mentioned standardized measures. Not all students received the same measure, nor did they receive the same test at the re-evaluation period (Time 2) that was administered at the initial evaluation period (Time 1). While the use of different cognitive tests across time is common in clinical practice, this creates certain challenges in research due to differences in the tests' standard deviations. These differences are, in part, accounted for through the use of standard z scores, and allow adequate comparisons between IQ scores from different tests.

Achievement measures
Academic achievement was assessed through the use of one of the following tests: Woodcock-Johnson Psycho-Educational Battery (Woodcock & Johnson, 1977), The Woodcock-Johnson Psycho-Educational Battery - Revised (Woodcock & Johnson, 1989), or the Wechsler Individual Achievement Test (The Psychological Corporation, 1992). From the period of 1984 to 2000, these tests represented some of the most widely used standardized measures of achievement.

Each student took one of the three achievement measures. The achievement test that was administered at Time 1 was also administered again at Time 2. Therefore, while there were differences in achievement tests used across students, there was consistency in the achievement measures that each individual student received. The lowest achievement subtest score at Time 1 was selected for comparison with the IQ score. At Time 2, the new score from the same achievement subtest selected at Time 1 was used for comparisons with the Time 2 IQ score. All achievement scores were converted to z scores, allowing for the consistent assessment of achievement gains or losses over time.

Discrepancy scores
Achievement z scores were used in conjunction with cognitive z scores to evaluate students' remediation. Time 1 discrepancy scores were calculated by subtracting achievement z score from the cognitive z score at Time 1 for each student. Likewise, the Time 2 discrepancy scores were calculated by subtracting students' Time 2 achievement z score from their Time 2 cognitive z score.

Change in Discrepancy scores
The discrepancy change score was the variable used to assess the remediation of learning disabilities. The change in the discrepancy score was selected as a measure of remediation because it most closely reflects changes in academic achievement based on traditional diagnostic criteria. It is reasonable to presume that as a child is remediated, there will be a consequent narrowing of the gap between their cognitive ability and academic achievement scores. The effect of remediation, or discrepancy change score, was calculated by subtracting the Time 1 discrepancy score from the Time 2 discrepancy score. Thus, greater positive values reflect greater remedial gains and greater negative values indicate remedial loss.

Socioeconomic status
School socioeconomic status was determined using the amount of spending per student. The mean school district expenditure was $7252 per pupil (SD=1305), and the range was from $5,400 to $11,627 per pupil. This measure has been used in other research studies to examine the effects of school SES and academic achievement in non-learning disabled populations (e.g., Miller-Whitehead, 2001; Miller-Whitehead & Achilles, 2003; Sutton & Soderstrom, 2001).

Results
It was hypothesized that IQ, age at diagnosis, school SES and student transfer status would be significantly related to the remediation of learning disabilities as measured by changes in the cognitive-achievement discrepancy over time. To correct for violations of normality, school SES was transformed through an inverse transformation, and the discrepancy change score was transformed using a square root transformation. The hypotheses were tested using a hierarchical multiple regressions, with IQ scores, age at diagnosis, school SES and student transfer status entered in the first block. The two-way interactions of the independent variables were entered into the second block. The results for the overall regression model was significant, $R^2 = .10$, $F (10,175) = 1.94$, $p < .05$ (see Table 2-next page). The first step in the model was significant, $R^2 = .07$, $F (4,171) = 3.27$, $p < .01$. Specifically, the relationship between IQ at Time 1 and discrepancy change scores was significant; $\beta = -0.18$, $p < 0.05$; students with higher cognitive scores tended to show greater improvement. Age at diagnosis was also significantly related to discrepancy change scores, $\beta = 0.16$, $p < 0.05$; greater remedial gains were observed in children that began treatment at younger ages. The results for the

main effects of SES and of student transfer status, however, were not significant nor were any of the interactions.

As IQ and age at diagnosis were significant, and transfer status was not, a follow-up analysis was conducted to examine whether transfer students differed from resident students on these two variables. T-tests indicated that the voluntary transfer students had significantly lower cognitive scores (as measured in z scores; M = -0.39 versus M = 0.11) and were older at time of diagnosis (M = 10.3 versus M = 9.3). The mean difference in school SES, however, was not significant. This suggests that voluntary transfer students are an at-risk population, not because of their voluntary transfer status per se, but because of their overall lower cognitive scores and later identification.

Table 2
Prediction of Discrepancy Change Scores from Student Transfer Status and School SES

Predictor variables	β	$R^2\Delta$	F (df) $R^2\Delta$
Step 1: Main effects		0.07	3.27 (4,171)**
IQ Z score at T1	-0.18*		
Age at diagnosis	0.16*		
School SES	0.04		
Student Transfer status	0.03		
Step 2: Interaction effects		0.03	1.94 (6,165)
IQ x Student Transfer Status			
IQ x Age			
IQ x School SES			
Age x Student Transfer Status			
Age x School SES			
Student Transfer Status x School SES			
Full Model		0.10	1.94 (10, 175)*

*p<0.05, **p<0.01

Discussion

The deleterious effects of LD on children's academic and occupational future has prompted large scale, government mandated remediation programs. This study sought to augment existing research on factors related to treatment outcome through a longitudinal examination of children in a number of school districts, which included a large number of voluntary transfer students. This study is unique in several regards: The sample was taken from a real world context; the three year time span is longer, and the number of school districts is greater, than most studies; it affords the possibility to confirm the generalizability of prior research on IQ and remediation outcome; and it examines age at identification, school SES, and voluntary transfer status, which have received little prior attention.

The results indicate that IQ was significantly related to remediation, as higher IQ was associated with greater improvement. This is congruent with prior research, conducted in more controlled settings, utilizing standardized tests with older children, suggesting that these findings may generalize to typical school populations where treatment is influenced by pragmatic concerns, not research protocols. Indeed, given the *noise* in this system, the detection of a significant and confirming relationship is noteworthy. IQ has consistently been found to be related to school performance and academic skills, and the results of this and other studies may reflect that children with higher IQs more effectively utilize and benefit from academic tutorial.

IQ is, of course, controversial, especially in regard to both the definition and treatment of LD. Some argue that it is a flawed basis for determining LD, and that remediation should be prompted by a failure to respond to intervention. The results of this study do not support, or refute, the arguments about the merits of the IQ-discrepancy score or the RTI controversy. Rather, they suggest that when the IQ-discrepancy definition is used for placement, which continues to be the approach in many school districts, IQ may be related to treatment outcome. Furthermore, the results could be used to argue for more intensive services and closer follow-up and follow-through for children with lower IQ.

Age at identification was also found to be related to treatment outcome; early identification, greater remediation. Age at identification has been recognized as an important variable and, indeed, is one

aspect of the RTI critique against using discrepancy scores to define LD. That is, the discrepancy definition results in a *waiting to fail* rather than a proactive, early identification and remediation (Fuchs & Young, 2006*).* The findings of this study suggest that such concern is well-founded—early identification matters. These results also underscore the urgency and importance of making every effort at early detection.

The results for school SES and transfer status were not significant, nor was the hypothesized interaction. Few studies have examined these factors, and the failure to find significant differences does not mean that future research is unwarranted. Rather, there is good theoretical reason to suspect that these factors might be important to remediation outcome. Furthermore, these variables are linked to broader sociological issues and public policies, which impact millions of students, and needs to be informed by empirical research. The paucity of research is disproportionately small in comparison to the magnitude of the public policy issues engendered by these variables. The follow-up analyses, which indicated that voluntary transfer students evinced lower IQ and later identification, suggest that they are an at-risk population for remediation of LD.

There are, of course, a number of limitations to this study. Because this was a relatively large-scale field study examining children across a number of school districts over a considerable time span, consistency was not possible. Different measures of IQ and achievement were used across students, and sometimes different IQ measures were used for the same student between time 1 and time 2. Although *z* scores were used to standardize comparisons between tests, the differing norms, populations, and emphases of these tests not only introduces measurement error, but raise questions about the assumptions that the tests can be considered statistically interchangeable. Furthermore, the sample spans a 16-year period, where policies, procedures and practices likely changed, which undercuts presumptions of assessment homogeneity and treatment fidelity.

The flaws and problems, significant as they are, are unavoidable consequences of the nature of this study that also affords a unique and potentially important approach; a large scale, three year longitudinal assessment of factors influencing the remediation of LD in a real world setting. The limitations of this study prevent confident conclusions and certainly don't trump research findings in more controlled contexts. The study does, however, offer complementary findings that are worthy of consideration: That in real world settings, IQ and age of identification may play a role in remediation that, consequently, entail important practical implications. This study also addressed the relation of school SES and transfer status, which have received little prior attention. Although the results were not significant, the practical, political, and societal implications of these factors on public policy decisions demand that they be more systematically investigated under more rigorous experimental conditions.

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