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# Academic Processing Speed Mediates the Influence of Both Externalizing Behavior and Language Skills on the Academic Skills of Students with Emotional Disturbance

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# Academic Processing Speed Mediates the Influence of Both Externalizing Behavior and Language Skills on the Academic Skills of Students with Emotional Disturbance

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**Abstract**
The results from previous research suggest that there is a relatively small (albeit statistically significant) relationship between the externalizing behavior and academic skills of students with emotional disturbance (ED). Researchers have also found that the majority of these students have language deficits that hinder their academic performance. The purposes of this study were to investigate the mediating role of academic processing speed (i.e., academic fluency) on the relationship between: (a) The externalizing behavior and academic skills of K-12 students with ED; and (b) language skills and academic skills of students with ED. Results indicate that academic processing speed mediated the influence of both language skills and externalizing behavior on academic skills of this population. The findings, limitations, and implications were discussed.

**Keywords:** emotional disturbance, academic fluency, language skills, emotional and behavioral disorders, academic skills, processing speed, externalizing behavior, language skills

## Introduction

Students with emotional disturbance (ED) are likely to evince deficits in academic skills. Trout et al. (2003) conducted a comprehensive review of studies in which researchers investigated the academic functioning of students with ED. Researchers of 91% (i.e., 31 of 35) of the studies reviewed over a 40-year time frame (i.e., 1961–2000) reported that students with ED showed substantial deficits in academic skills (i.e., below grade level or one or more years behind their peers). Further, the gap in the academic functioning between students with ED and those without disabilities was found to be moderate to large (Effect Size = −0.69) (Reid et al. 2004). Given the academic difficulties of many students with ED, it is of interest to identify factors that influence their academic skills.

Researchers to date have focused on the types of problem behavior related to the academic skills of students with ED (Barriga et al. 2002; Mattison et al. 1998; Nelson et al. 2004). Researchers have mostly relied on categorical or clinical diagnostic systems such as the Diagnostic and Statistical Manual of Mental Disorders (DSM) in these studies. For example, Mattison et al. (1998) used the DSM-III (American Psychiatric Association 1980) to examine the categories of problem behavior that are related to the academic achievement of students with ED. These researchers found that conduct/oppositional disorder was related to academic achievement of a convenience sample of elementary and secondary aged students with ED. Moreover, researchers of the Multimodal Treatment Study (Abikoff et al. 2002) found that the presence of co-morbid Attention Deficit Hyperactivity Disorder and Disruptive Behavior Disorders were more strongly related to academic achievement deficits than either psychiatric disorders alone or in combination.

Nelson et al. (2004) extended this work by using a dimensional classification system and multiple regression approach to examine the differential strength of the relationship between externalizing and internalizing behavior and the academic functioning of K-12 students with ED. Externalizing behavior (i.e., aggression, delinquent, and attention problems), but not internalizing ones (i.e., withdrawn, somatic complaints, anxious/depressed, social problems, and thought problems) were related to the academic functioning (i.e., reading, mathematics, and writing) of students with ED (Nelson et al. 2004). Further, although statistically significant, the unique contribution of externalizing behavior to the prediction of academic functioning was relatively small (i.e., 14% of the variance).

The purposes of this study were to investigate the mediating effect of academic processing speed (described below) on the relationship between: (a) The externalizing behavior and academic skills of K-12 students with ED; and (b) language skills and academic skills of students with ED. We investigated the mediating effect of academic processing speed for three reasons. First,

there is substantial evidence in the area of reading that academic processing speed plays such a role in students' acquisition of proficient reading skills (e.g., Al Otaiba and Fuchs 2002; Berninger et al. 2001; Compton 2003; Bowers et al. 1999; Nelson et al. 2003). Second, the results of research conducted with normally developing third and fourth grade children suggests that academic processing speed (i.e., rapid automatic naming of letters, digits, and colors) is related to children's reading ability but not to teacher ratings of their behavior (i.e., inattention, hyperactive) (Stringer et al. 2004). Third, language skills are critical to academic skills (e.g., Catts et al. 1999; National Research Council 1998; NICHD Early Child Care Research Network 2005). Many children with language deficits have underlying cognitive processing delays, particularly those with ED (Beitchman et al. 1998; Hooper et al. 2003; Mattison et al. 2006; Rogers-Adkinson 2003). About two of three of students with ED have language deficits that worsen over time and hinder academic performance (Benner et al. 2002; Nelson et al. 2005). Taken together, we hypothesized that academic processing speed would mediate the influence of both language skills and externalizing behavior on the academic skills of students with ED.

Processing speed is operationalized in multiple ways in fields such as cognitive psychology (e.g., Fry and Hale 1996), language development (e.g., Catts et al. 1999), reading (e.g., Compton 2003), and genetics (e.g., Davis et al. 2001). For example, in the field of reading, processing speed is typically referred to as rapid automatic naming and is operationalized as the ability to make quick visual-verbal associations of stimuli in a left-to-right format (Wolf and Bowers 1999). Furthermore, processing speed has been identified as underlying many academic (e.g., decoding, mathematical computation) and cognitive skills (e.g., working memory, verbal ability) (Fry and Hale 1996). For the purposes of this study we use the term "academic processing speed" to refer to an overall cognitive ability as reflected in the Carroll–Horn–Cattell model of cognitive function on which the Woodcock-Johnson-III is based (*WJ-III*: Woodcock et al. 2001). Specifically, we operationalized academic processing to mean the fluent and automatic use of basic academic skills in reading, mathematics, and writing as reflected in the Academic Fluency Cluster of the WJ-III. The following two empirically based hypotheses provide the rationale for testing the mediating effect of academic processing speed on the relationship between: (a) The externalizing behavior and academic skills of K-12 students with ED; and (b) language skills and academic skills of students with ED.

## Hypotheses

***Hypothesis 1:*** Academic processing speed is positively related to academic skills and mediates the relationship between externalizing behavior and academic skills.

There is ample evidence to hypothesize that academic processing speed is positively related to academic skills. Processing speed has been identified as underlying many academic (e.g., decoding, mathematical computation) and

cognitive skills (e.g., working memory, verbal ability) (Berninger and Richards 2002; Fry and Hale 1996). For example, there is clear evidence in the field of reading (Berninger et al. 2001; Compton 2003; Sunseth and Bowers 2002) that processing speed or serial rapid automatic naming (i.e., ability to make quick visual-verbal associations of stimuli in a left-to-right format) is critical to proficient reading. Further, these skills are the strongest and most consistent predictors in discriminating the most difficult and least difficult to remediate students in grades 1–3.

***Hypothesis 2:*** Academic processing speed is positively related to language skills and mediates the relationship between language skills and academic skills.

The positive relationship between language skills and academic processing speed is logical given that language development is not restricted to the acquisition of words or rules (Owens 2001). To comprehend language, a child must engage in very rapid processing of phonological, lexical/semantic, grammatical and syntactic information presented to them. The child must also take advantage of the context to access and integrate information over multiple levels, with millisecond timing (Catts et al. 1999; Kail 1994). The capacity of a student to rapidly process information in academic contexts and produce appropriate responses impacts academic performance (Berninger and Richards 2002).

## Methods

### Participants

One hundred sixty-six (136 boys and 30 girls) students (K-12) receiving special education services for ED in a medium sized urban school district in the Mid-west served as participants in the present study. The district is a relatively high achieving district with above average mean standardized test (Metropolitan Achievement Test: MAT9) scores at the third and eighth grades (e.g., third grade reading NCE = 75). Approximately 65% of the students with ED receiving special education services were eligible for free or reduced lunch. The 166 participating students were part of 260 students (20 each from Kindergarten through 12th grade) who were randomly selected from all of the students receiving special education services for ED. Project staff contacted the parents/guardians of the initial pool of students to explain the purposes of the study and obtain informed consent and child assent to participate in the project. Approximately 64% of the parents/guardians allowed their children to participate in the present study, resulting in a total of 166 participating students.

The gender, mean age, age of onset (age when formally diagnosed as ED), total academic achievement score, total problems, and mean full scale IQ scores for each grade (K-12) are presented in Table 1. One hundred and thirty-three (85%) of the participants were Caucasian, 16 (11%) were African

**Table 1.** Grade level averages of participants across categories

| Grade/gender | Age | Age of onset | Total achievement | TRF total problems | Full scale IQ |
|---|---|---|---|---|---|
| K (5 boys) | 6.28 (0.42) | 4.33 (10.25) | 81.60 (12.12) | 64.40 (9.74) | 84.60 (16.55) |
| 1st (13 boys; 2 girls) | 7.10 (0.40) | 5.53 (0.94) | 96.26 (14.68) | 68.07 (7.53) | 96.64 (9.41) |
| 2nd (12 boys; 2 girls) | 8.01 (0.39) | 6.27 (1.29) | 90.64 (18.93) | 65.50 (6.04) | 92.29 (19.29) |
| 3rd (11 boys; 4 girls) | 9.25 (0.53) | 6.74 (1.98) | 86.40 (19.46) | 66.93 (10.41) | 93.87 (14.38) |
| 4th (10 boys; 4 girls) | 10.03 (0.27) | 7.65 (1.49) | 90.43 (16.69) | 70.21 (7.92) | 101.79 (13.22) |
| 5th (9 boys; 4 girls) | 11.09 (0.40) | 7.87 (1.56) | 89.62 (16.33) | 62.00 (9.91) | 98.46 (16.19) |
| 6th (12 boys) | 11.92 (0.42) | 7.82 (1.90) | 92.42 (16.37) | 69.83 (8.90) | 101.83 (11.73) |
| 7th (9 boys; 2 girls) | 13.01 (0.29) | 8.48 (2.08) | 82.64 (19.35) | 64.82 (5.56) | 92.27 (11.69) |
| 8th (12 boys; 2 girls) | 14.10 (0.42) | 10.46 (2.94) | 88.93 (10.22) | 68.34 (6.67) | 94.64 (15.03) |
| 9th (13 boys; 3 girls) | 15.29 (0.47) | 10.26 (2.13) | 87.13 (17.15) | 60.31 (5.49) | 96.63 (18.11) |
| 10th (10 boys; 3 girls) | 16.23 (0.45) | 11.92 (2.68) | 88.38 (17.06) | 61.54 (7.56) | 97.77 (19.97) |
| 11th (7 boys; 1 girl) | 17.34 (0.51) | 10.48 (3.76) | 81.25 (24.87) | 68.25 (4.59) | 100.12 (14.89) |
| 12th (5 boys) | 18.60 (1.73) | 9.57 (4.08) | 97.20 (23.24) | 59.40 (2.07) | 102.20 (24.15) |

Values represent averages. The values in parentheses represent standard deviations. Age of onset was the age of diagnosis when the student began special education services under the category of emotional disturbance. Total Achievement was measured using the Woodcock-Johnson III Tests of Achievement (WJ-III) (Woodcock et al. 2001). TRF Total Problems was the overall score generated from the Child Behavior Checklist: Teacher Report Form (*TRF*) (Achenbach 1991)

American, 3 (2%) were Latino, and 3 (2%) were Native American. The ethnic makeup of our sample was consistent with the total population of students with ED served by the school district, but under-representative of African-American and Hispanic/Latino nationally. Furthermore, the ratio of boys to girls in the sample was consistent with the total population of students with ED served nationally (Kauffman 2001). Breakdowns of participants by grade level groups, gender, standardized language test scores, and behavioral profiles have been detailed previously (Nelson et al. 2004, 2005).

## Research Design

A cross-sectional research design (Martella et al. 1999) was used to collect information on the 166 randomly selected participants within a contemporaneous 4-month time span. Children with ED were randomly selected from the population of all children with ED at each grade level (K-12) across one school district. All of the data were collected February through May of the 2001–02 academic year.

## Construct Definitions and Measures

Multi-item scales were used to measure each of the four constructs: Externalizing behavior, academic processing speed, academic skills, and language. The construct definitions and descriptions of the associated measurement scales follow.

*Externalizing Behavior*

The construct of externalizing behavior refers to a grouping of behavior problems that are manifested in children's outward behavior and reflect the child negatively acting on the external environment (Walker and Severson 1990). The Child Behavior Checklist: Teacher Report Form (TRF) (Achenbach 1991) Attention Problems, Delinquent Behavior and Aggressive Behavior narrow band scales were used to measure the externalizing behavior of participants. These scales comprise the TRF Externalizing broad band scale. The teacher rates the child on each scale item by indicating the severity of the problem on a scale of zero (no problem) to two (severe problem). The internal consistency values for the Attention Problems, Delinquent Behavior and Aggressive Behavior narrow band scales are 0.89, 0.86, and 0.92, respectively (Achenbach 1991).

*Academic Processing Speed*

The construct of processing speed refers to the ability to work quickly and maintain focused attention when measured under pressure (Berniger and Richards 2002; Fry and Hale 1996). The Woodcock-Johnson III Tests of Achievement (WJ-III) (Woodcock et al. 2001) Math Fluency, Reading Fluency, and Writing Fluency subtests were used to measure the academic processing speed of participants. These subtests comprise the WJ-III Academic Fluency cluster. For the Math Fluency subtest, students write the answers to basic addition, subtraction and multiplication facts within a 3-min time limit. Students read a series of statements and circle yes or no to indicate whether they are true or false within a 3-min time limit for the Reading Fluency subtest. For the Writing Fluency subtest, students write sentences describing what is depicted in stimulus pictures within a 7-min time limit. The test-retest reliabilities for the WJ-III Math Fluency, Reading Fluency, and Writing Fluency subtests are 0.90, 0.90, and 0.88, respectively (Woodcock et al. 2001).

*Academic Skills*

The construct of academic skills refers to fundamental reading, mathematic, and spelling skills that underlie more advanced achievement competencies such as math reasoning and reading comprehension. The WJ-III Calculation, Letter-Word Identification, and Spelling subtests (Woodcock et al. 2001) were used to measure the academic skills of participants. These subtests comprise the WJ-III Academic Skills cluster. The Calculation scale requires students to complete computations from simple addition facts to complex algebraic equations. The Letter Word Identification scale requires students to identify and pronounce isolated words and letters. The Spelling subtest requires students to spell words presented orally. The test-retest reliabilities for the Letter-Word Identification, Calculation, and Spelling subtests are 0.94, 0.86, and 0.90, respectively (Woodcock et al. 2001).

*Language*

The construct of language refers to the ability to understand and use words effectively either orally or in writing (Owens 2001). The Clinical Evaluation of Language Fundamentals, Third Edition (CELF-III) (Semel et al. 1995) Receptive and Expressive scales and Wechsler Intelligence Scale for Children, Third Edition (WISC-III: Wechsler 1991) Verbal scale were used to measure the language skills of participants. The CELF-III subtests include Sentence Structure, Word Structure, Concepts and Directions, Formulated Sentences, Word Classes, Recalling Sentences, Sentence Assembly, and Semantic Relationships. The three Receptive (Sentence Structure, Concepts and Directions, and Word Classes) and Expressive (Word Structure, Formulated Sentences, and Recalling Sentences) subtests for students 6–8 years differ from the Receptive (Concepts and Directions, Word Classes, and Semantic Relationships) and Expressive (Formulated Sentences, Recalling Sentences, and Sentence Assembly) subtests for students 9 years and older. Regardless of age, the Receptive and Expressive scale scores are based on the sum of the three respective subtest scores. The test-retest reliabilities of the Receptive and Expressive scales are 0.86 and 0.88, respectively (Semel et al. 1995). Additionally, the WISC-III Verbal scale includes the General Information, General Comprehension, Arithmetic, Similarities, Vocabulary, and Digit Span subtests. The test-retest reliability of the Verbal scale is 0.94 (Wechsler 1991).

## Procedures

*Training*

Data collectors were trained to administer the CELF-3 and WJ-III and to manage the behavior of students during testing. Eight hour training sessions occurred weekly for 1 month. Training sessions were conducted using the training procedures outlined by the authors of the CELF-3 and WJ-III. To demonstrate mastery of test administration, data collectors were observed delivering the test to a child under simulated conditions until mastery of test administration was reached. Fidelity was assessed using a modified version of the observation checklist created by authors of the CELF-3 and WJ-III. When the data collector administered the test with 95% fidelity under simulated test conditions, the data collector was approved to test in the schools.

*Fidelity*

Fidelity checks were conducted prior to test administration and on every third test administration. Fidelity was calculated by dividing total number of occurrences (e.g., following testing script) and non-occurrences (e.g., not following testing script) by the total number of occurrences for each of the items on the observation checklists for the WJ-III and CELF-III. Item by item fidelity for administration of the CELF-3 ranged from 97 to 100%. Item

by item fidelity for administration of the WJ-III ranged from 95 to 100%. Overall fidelity was 99% and 97% for administration of the CELF-3 and WJ-III, respectively.

*Testing*

The CELF-3 and WJ-III were administered to each student with ED in a quiet area of the school. Assessment was staggered over two or more days to obtain the student's best performance. Moreover, the examiner divided testing into two 15–20 minute sessions to improve attention to each CELF-3 and WJ-III task.

## Analyses

Baron and Kenny (1986) procedure for assessing mediation is the most commonly used method and fairly representative in the major journals in psychology research (MacKinnon et al. 2002). To test for simple mediation with only one mediator involved, follow Baron and Kenny procedure, three regression equations should be performed: Regression of mediator (e.g., processing speed) on independent variable (e.g., externalizing behavior), regression of dependent variable (e.g., academic skills) on independent variable, and regression of dependent variable on both mediator and independent variable. Mediation is considered if the following criteria are met: Independent variable predicts mediator, independent variable predicts dependent variable, and mediator predicts dependent variable controlling for independent variable. Mediation is said to have occurred when the effect of independent variable on dependent variable changes with the inclusion of mediator by a non-trivial amount (Preacher and Hayes 2004).

Baron and Kenny procedure is used to detect if there is mediation or not. Indirect effect is used to measure the amount of the mediation. A significance test of mediation proposed by Sobel (1982) is highly recommended by many researchers. The Sobel test provides the standard error of the indirect effect ($s_{ab}$) can be shown as

$$s_{ab} = \sqrt{b^2 s_a^2 + a^2 s_b^2}$$

The test of the indirect effect is given by dividing $ab$ by $s_{ab}$, and then the ratio is compared with the critical value ($Z$) from the standard normal distribution. The Sobel test is conservative since it requires large sample size. Simulation study examining the effects of factors on the power of the tests of mediation has been performed by some researchers (Frazier et al. 2004), only samples of 200 or larger had sufficient power. This may be problematic for our data since our sample size is only 166.

A more powerful strategy for testing mediation when low power exists is to add bootstrapping technique into Sobel (1982) test. Bootstrapping is based on random samples drawn from the original data set, and it is a non-para-

metric approach requiring no assumptions about the shape of the distribution and not based on large sample size.

Preacher and Hayes (2004) implemented macros for SPSS that provide (1) detection of mediation using Baron and Kenny procedure, (2) a test of the indirect effect using the Sobel test, and (3) a test of the indirect effect using the Sobel test with the bootstrapping technique added. The electronic copy of the macros can be downloaded at http://www.comm.ohio-state.edu/ahayes/sobel.htm .

## Results

The Preacher and Hayes (2004) SPSS macros were employed to test the two hypotheses posed previously. The output from SPSS macros contain regression analysis using Baron and Kenny criteria (Table 2), indirect effect using Sobel test (Table 3), and indirect effect using the bootstrapping technique (Table 4). The specified models are depicted in Figure 1.

In support of hypothesis 1 (Table 2, model 1), the effect of externalizing behavior on academic skills (total effect) is not statistically significant ($p > 0.05$); the effect of externalizing behavior on academic processing speed

**Table 2.** Detecting mediation using regression analysis with Baron and Kenny criteria ($N = 145$)

| | Detecting steps in mediation model | B | SE B | $\beta$ |
|---|---|---|---|---|
| Model 1 | Step 1 (Path c) | | | |
| | Outcome: Academic skills | | | |
| | Predictor: Externalizing behavior | −0.199 | 0.137 | −0.121 |
| | Step 2 (Path a) | | | |
| | Outcome: Academic processing speed | | | |
| | Predictor: Externalizing behavior | −0.275 | 0.135 | −0.168* |
| | Step 3 (Paths b and c′) | | | |
| | Outcome: Academic skills | | | |
| | Mediator: Academic processing speed (Path b) | 0.763 | 0.057 | 0.753* |
| | Predictor: Externalizing behavior (Path c′) | 0.010 | 0.093 | 0.006 |
| Model 2 | Step 1 (Path c) | | | |
| | Outcome: Academic skills | | | |
| | Predictor: Language skills | 0.623 | 0.063 | 0.637* |
| | Step 2 (Path a) | | | |
| | Outcome: Academic processing speed | | | |
| | Predictor: Language skills | 0.566 | 0.065 | 0.587* |
| | Step 3 (Paths b and c′) | | | |
| | Outcome: Academic skills | | | |
| | Mediator: Academic processing speed (Path b) | 0.584 | 0.064 | 0.577* |
| | Predictor: Language skills (Path c′) | 0.291 | 0.062 | 0.299* |

* $p < 0.05$

is statistically significant ($p < 0.05$); the effect of processing speed on academic skills, controlling for the externalizing behavior is statistically significant ($p < 0.05$). Since one of the Baron and Kenny (1986) criteria is violated,

**Table 3.** Mediator (indirect) effect using Sobel test

| | | Value | SE | LL 95 CI | UL 95 CI |
|---|---|---|---|---|---|
| Indirect effect | Model 1 | −0.2096 | 0.1041 | −0.4137 | −0.0055 |
| | Model 2 | 0.3309 | 0.0529 | 0.2272 | 0.4347 |

*SE* = standard error, *CI* = confidence interval

**Table 4.** Mediator (indirect) effect using bootstrapping technique (number of bootstrap = 5,000)

| | | Value | SE | LL 95 CI | UL 95 CI |
|---|---|---|---|---|---|
| Indirect effect | Model 1 | −0.2118 | 0.982 | −0.4038 | −0.0158 |
| | Model 2 | 0.3324 | 0.0546 | 0.2300 | 0.4462 |

*SE* = standard error, *CI* = confidence interval

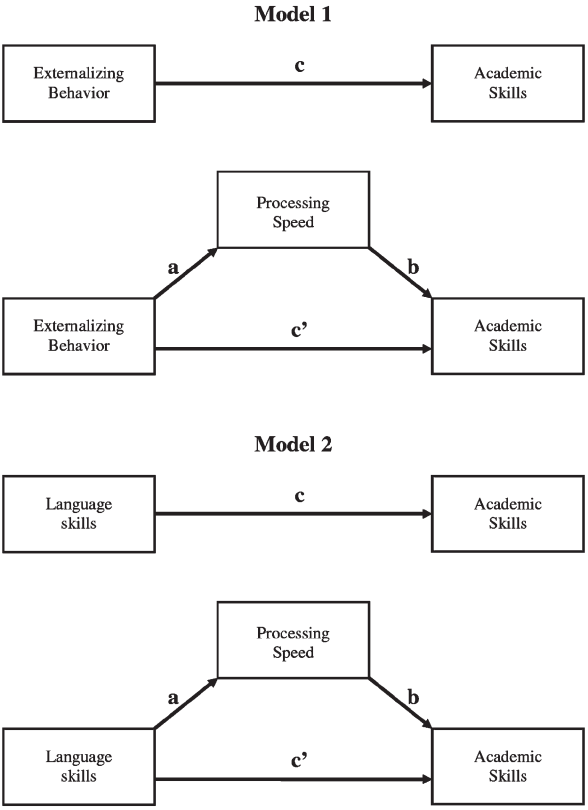


**Figure 1.**
The mediation model

we cannot be sure if there is mediation, but we know that externalizing behavior has no initial direct effect on academic skills. However, there is evidence that the externalizing has an indirect effect on academic skills with the effect occurring through academic processing speed. The output of the Sobel test (Table 3, model 1) contains the estimate of the indirect effect of externalizing behavior on academic skills through academic processing speed to be -0.2096. This test suggests that the mediation has occurred since $p < 0.05$ level. The output of bootstrap (Table 4, model 1) shows that the indirect effect is significant with 95% confidence since the confidence interval does not include zero, this result is consistent with Sobel test. Hence, the indirect effect is statistically significant, and we can conclude that the externalizing behavior does have an indirect effect on academic skills, with the effect occurring through academic processing speed.

In support of hypothesis 2 (Table 2, model 2), the effect of language skills on academic skills (total effect) is statistically significant ($p < 0.05$); the effect of language skills on academic processing speed is statistically significant ($p < 0.05$); the effect of academic processing speed on academic skills, controlling for the language skills is statistically significant ($p < 0.05$). The Baron and Kenny (1986) criteria are established. Finally, the effect of language skills on academic skills decreased with the inclusion of academic processing speed (from 0.623 to 0.291). Therefore, we can conclude that the academic processing speed mediates the effect of language skills on academic skills. Moreover, both output of Sobel test (Table 3, model 2) and bootstrap (Table 4, model 2) show that the indirect effect of language skills on academic skills through academic processing speed is significant since $p < 0.05$ level and 95% confidence interval does not include zero.

## Discussion

Students with ED tend to experience global academic delays in academic functioning that begin early and are often recalcitrant to academic interventions (Trout et al. 2003). Researchers have studied the type of and extent to which problem behaviors and language skills are related to the academic skills of students with ED (e.g., Barriga et al. 2002; Benner et al. 2002; Nelson et al. 2004, 2005). The purposes of this study were to investigate the mediating effect of academic processing speed on the relationship between: (a) The externalizing behavior and academic skills; and (b) language skills and academic skills of k-12 students with ED.

Academic processing speed mediated the influence of both language ability and externalizing behavior on academic skills. Obviously, students' ability to efficiently process academic information and produce appropriate responses facilitated the students' academic skills (Berninger and Richards 2002; Fry and Hale 1996). Externalizing behavior was negatively related to academic processing speed (Al Otaiba and Fuchs 2002). Academic processing speed was positively related to academic skills (Woodcock et al. 2001) and mediated the negative relationship between externalizing behavior and academic skills. Academic processing speed was positively related to language

skills and mediated the relationship between language skills and academic skills. The model also indicated that language ability was negatively related to externalizing behavior suggesting students with better language ability were more likely to have lower levels of externalizing behaviors.

The results of this study are consistent with those of research conducted on the relationships between rapid automatic naming (i.e., letters, digits, and colors) and behavior ratings and reading ability (Stringer et al. 2004). The rapid naming of letters and digits was significantly correlated with children's reading ability, but not with teacher ratings of their behaviors (i.e., inattention, hyperactivity) of students. The results of this study are also consistent with the work of researchers who reported that language and cognitive processing speed appear to underlie the social adjustment, language, and learning problems of students with ED (Hinshaw 1992; Hooper et al. 2003; Hooper and Tramontana 1997; Rogers-Adkinson 2003; Mattison et al. 2006).

Converging evidence for our finding that academic processing speed mediates the influence of both language ability and externalizing behavior on academic skills is found in several academic disciplines. For example, researchers have examined the effects of literacy interventions on the social behavior of young children with ED (Nelson et al. 2005). Sixty-three kindergarten children with concurrent phonological deficits and behavioral problems were randomly assigned to a pre-reading intervention or non-specific treatment condition. Children who received the pre-reading intervention made statistically and educationally significant gains on the standardized and curriculum-based literacy measures but not in teacher ratings of their social behaviors relative to children in the non-specific treatment condition. Converging evidence for our finding that academic processing mediates the strength of the relationship between externalizing behavior and academic skills is also provided by the work of researchers in the field of reading who have found a connection between serial automatic naming and reading ability (e.g., Berninger et al. 2001; Compton 2003; Wolf and Bowers 1999). Rapid automatic naming has been found to add unique variance to the prediction of reading ability even beyond that explained by the best individual predictor variable, phonological processing skill (see for reviews Manis et al. 1999; Wolf and Bowers 1999). These results are also consistent with research findings in several other fields, including genetics (e.g., Davis et al. 2001), language (e.g., Catts et al. 1999; Weckerly et al. 2001), and the neurosciences (Wolf et al. 2000). Research across multiple disciplines seems to indicate that processing speed is critical to proficient academic skills and many cognitive skills including verbal ability and reasoning.

## Limitations

There are several limitations to the findings that should be noted. First, the sample of children was drawn from one school district in one geographic location and may not be representative of the general population of public school students with ED. It is possible that the findings may not generalize to other students in other geographical regions and schools. Future research should replicate these finding across varied contexts. Second, the sample size

was somewhat limited as a sample above 200 would yield more reliable results (Kline 1998). For example, the output of the Sobel test (Table 3, model 1) may be suspicious because the test is based on the assumption that the effect distribution follows a normal distribution and the sample size of 166 may not be large enough. Finally, although the pragmatic hypotheses and robust findings of the regression procedures used to test for mediation would seem to suggest that these constructs are valid, these findings are in fact just one test of a possible model explaining a mediating relationship between academic processing speed on the relationships between language ability, externalizing behavior, and academic skills. It may be that the interrelationships among language, externalizing behavior, and processing speed and their influence on academic skills may vary if they were operationalized in different ways. For example, Stringer et al. (2004) reported that different versions of rapid automatic naming (e.g., letters versus colors) or even different stimuli with a single version might draw on different aspects of academic processing speed. The results of research on rapid automatic naming indicates that the processing of object or color stimuli is more involved that the processing of letter or digit stimuli (Wolf and Bowers 1999). Future studies should use measures that operationalize the constructs studied in this paper in various ways. It would be interesting to study, for example, what would happen to the mediating effect of academic processing speed if the number of and categorical clarity of the stimuli were varied. Finally, our study provides no information with which to answer the question of why academic processing speed mediates the relationship between externalizing behavior and academic functioning. Our study also does not provide information on other variables that might influence the academic functioning of students with ED. Consistent and sustained research should be undertaken to refine our understanding of the factors that influence the academic skills of students with ED.

## Implications

With the above limitations in mind, implications for practice are evident. First, our finding that academic processing speed mediated the influence of both language performance and externalizing behavior on academic skills underscores the need to provide intensive, well-organized behavioral and academic intervention programs to students with ED. Of course, a great deal of research is needed to refine our understanding of how best to intervene behaviorally and academically with such students. Students with ED continue to experience the poorest school outcomes relative to all other disabilities (e.g., Wagner 1995).

Second, the results of this study suggest that the academic functioning of students with ED may be increased through the use of instructional techniques that center on academic fluency building. In other words, once mastery of foundational academic tasks is achieved, the teacher should focus enhancing students' ability to effortlessly complete these foundational academic tasks without conscious thought to step-by-step process. When basic academic tasks become automatic, the brain recognizes these simple and

familiar tasks, processes the information, and automatically applies the correct rules to the procedure without immense cognitive effort (Schneider and Chein 2003). In the area of reading, fluency involves reading text accurately, quickly, and with proper expression (National Institute of Child Health and Human Development 2000). Because fluent readers do not have to concentrate on decoding the words, they can focus their attention on what the text means, whereas less fluent readers must focus their attention on figuring out the words, leaving them little attention for understanding the text (Armbruster et al. 2003; Berninger 2002). In the area of mathematics, fluent math fact retrieval and application of computational algorithms frees limited working memory resources for math problem solving. Indeed, researchers have found that fluency building in mathematics not only improves academic functioning, but also increases neurological activity in the area of the brain that deals with automatic retrieval of information (Delazer et al. 2004).

Finally, related to the above issue, educators should use fluency based screening and progress monitoring measures to identify and track the progress of students with ED who are experiencing academic difficulties. Fortunately, empirically validated Curriculum-Based Measurements (CBM) to screen and monitor the progress of students are widely available (e.g., Deno et al. 2001). These measures typically require the student to complete brief, timed exercises using materials drawn directly from the child's academic program. CBM not only provides teachers and parents technically adequate assessment data, it also has produced significant results on the performance and motivation of students with ED. Researchers have found that CBM produces mediate to large effect sizes (ES ≥ 0.5) on the academic fluency of students with high incidence disabilities, including those with ED (Shinn 2002).

## References

Abikoff, H. B., Jensen, P. S., Arnold, L. L. E., Hoza, B., Hechtman, L., Pollack, S., Martin, D., Alvir, J., March, J. S., Hinshaw, S., Vitiello, B., Newcorn, J., Greiner, A., Cantwell, D. P., Conners, C. K., Elliot, G., Greenhill, L. L., Kraemer, H., Pelham, W. E. Jr., Severe, J. B., Swanson, J. M., Wells, K., & Wigal, T. (2002). Observed classroom behavior of children with ADHD: Relationship to gender and comorbidity. *Journal of Abnormal Child Psychology, 30*, 349–359.

Achenbach, T. M. (1991). *Manual for the child behavior checklist/4–18 and 1991 profile*. Burlington: University of Vermont, Department of Psychiatry.

Al Otaiba, S., & Fuchs, D. (2002). Characteristics of children who are unresponsive to early literacy intervention. *Remedial and Special Education, 23*(5), 300–316.

Armbruster, B. B., Lehr, F., & Osborn, J. (2003). *Put reading first: The research building blocks for teaching children to read, kindergarten through grade 3*. Jessup, MD: National Institute for Literacy.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173–1182.

Barriga, A. Q., Doran, J. W., Newell, S. B., Morrison, E. M., Barbetti, V., & Robbins, B. D. (2002). Relationships between problem behaviors and academic achievement in adolescents: The unique role of attention problems. *Journal of Emotional and Behavioral Disorders, 10*, 233–240.

Beitchman, J. H., Cantwell, D. P., Forness, S. R., Kavale, K. A., & Kauffman, J. M. (1998). Practice parameters for the assessment and treatment of children and adolescents with language and learning disorders. *Journal of the American Academy of Child and Adolescent Psychiatry, 37*, 36s–62s.

Benner, G. J., Nelson, J. R., & Epstein, M. H. (2002). The language skills of children with emotional and behavioral disorders: A review of the literature. *Journal of Emotional and Behavioral Disorders, 10*, 43–59.

Berninger, V. W. (2002). Best practices in reading, writing, math assessment-intervention links: A systems approach for schools, classrooms, and individuals. In A. Thomas & J. Grimes (Eds.), *Best practices in school psychology IV* (pp. 851–865). Bethesda, MD: National Association of School Psychologists.

Berninger, V. W., Abbott, R. D., Billingsley, F., & Nagy, W. (2001). Processes underlying timing and fluency of reading: Efficiency, automaticy, coordination, and morphological awareness. In M. Wolf (Ed.), *Dyslexia, fluency, and the brain* (pp. 383–414). Timonium, MD: York Press.

Berninger, V. W., & Richards, T. L. (2002). *Brain literacy for educators and psychologists*. Boston: Academic Press.

Bowers, P. G., Sunseth, K., & Golden, J. (1999). The route between rapid naming and reading progress. *Scientific Studies of Reading, 3*, 31–53.

Catts, H. W., Fey, M. E., Xuyang, Z., & Tomblin, J. B. (1999). Language basis of reading and reading disabilities: Evidence from a longitudinal investigation. *Scientific Studies of Reading, 3*, 331–362.

Clark, L. A., & Watson, D. (1995). Constructing validity: Basic issues in objective scale development. *Psychological Assessment, 7*(3), 309–319.

Compton, D. L. (2003). Modeling the relationship between growth in rapid naming speed and growth in decoding skill in first grade children. *Journal of Educational Psychology, 95*, 225–240.

Davis, C. J., Gayan, J., Knopik, V. S., Smith, S. D., Cardon, L. R., Pennington, B. F., Olson, R. K., & DeFries, J. C. (2001). Etiology of reading difficulties and rapid naming: The Colorado twin study of reading disability. *Behavior Genetics, 31*, 625–636.

Delazer, M., Domahs, F., Bartha, L., Brenneis, C., Locky, A., Trieb, T. (2004). The acquisition of arithmetic knowledge—An fMRI study. *Cortex, 40*, 166–167.

Deno, S. L., Fuchs, L. S., Marston, D., & Shinn, M. (2001). Using curriculum-based measurement to establish growth standards for students with learning disabilities. *School Psychology Review, 30*, 507–524.

Frazier, P. A., Tix, A. P., & Barron, K. E. (2004). Testing moderator and mediator effects in counseling psychology. *Journal of Counseling Psychology, 51*(1), 115–134.

Fry, A. F., & Hale, S. (1996). Processing speed, working memory, and fluid intelligence: Evidence for a developmental cascade. *Psychological Science, 7*, 237–241.

Hinshaw, S. P. (1992). Externalizing behavior problems and academic underachievement in childhood and adolescence: Causal relationships and underlying mechanisms. *Psychological Bulletin, 111*, 127–155.

Hooper, S. R., Roberts, J. E., Zeisel, S. A., & Poe, M. (2003). Core language predictors of behavioral functioning in early elementary school children: Concurrent and longitudinal findings. *Behavioral Disorders, 29*, 10–24.

Hooper, S. R., & Tramontana, M. G. (1997). Advances in the neuropsychological bases of child, adolescent psychopathology: Proposed models, findings, and ongoing issues. In T. H. Ollendick & R. J. Prinz (Eds.), *Advances in clinical child psychology* (Vol. 19, pp. 133–175). New York: Plenum.

Kail, R. (1994). A method for studying the generalized slowing hypothesis in children with specific language impairment. *Journal of Speech and Hearing Research, 37*(2), 418–421.

Kauffman, J. M. (2001). *Characteristics of emotional and behavioral disorders of children and youth* (7th ed.). Upper Saddle River, NJ: Merrill Prentice Hall.

Kline, R. B. (1998). *Principles and practice of structural equation modeling*. New York: Guilford.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods, 7*, 83–104.

Manis, F. R., Seidenberg, M. S., & Dori, L. M. (1999). See dick RAN: Rapid naming and the longitudinal prediction of reading subskills in first and second graders. *Scientific Studies of Reading, 3*, 129–157.

Martella, R. C., Nelson, J. R., & Marchand-Martella, N. E. (1999). *Research methods: Learning to become a critical research consumer*. Boston, MA: Allyn and Bacon.

Mattison, R. E., Hooper, S. R., & Carlson, G. A. (2006). Neuropsychological characteristics of special education students with serious emotional/behavioral disorders. *Behavioral Disorders, 31*(2), 176–188.

Mattison, R. E., Spitznagel, E. L., & Felix, B. C. (1998). Enrollment predictors of the special education outcome for students with SED. *Behavioral Disorders, 23*, 243–256.

National Research Council (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy Press.

National Institute of Child Health and Human Development. (2000). *Report of the national reading panel. Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction: Reports of the subgroups* (NIH Publication No. 00-4754). Washington, DC: U.S. Government Printing Office.

NICHD Early Child Care Research Network. (2005). Pathways to reading: The role of oral language in the transition to reading. *Developmental Psychology, 41*, 428–442.

Nelson, J. R., Benner, G. J., & Cheney, D. (2005). An investigation of the language skills of students with emotional disturbance served in public school settings. *Journal of Special Education, 39*(2), 97–105.

Nelson, J. R., Benner, G. J., & Gonzalez, J. (2003). Learner characteristics that influence the treatment effectiveness of early literacy interventions: A meta-analytic review. *Learning Disabilities Research and Practice, 18*(4), 255–267.

Nelson, J. R., Benner, G. J., Lane, K., & Smith, B. W. (2004). An investigation of the academic achievement of K-12 students with emotional and behavioral disorders in public school settings. *Exceptional Children, 71*, 59–74.

Nelson, J. R., Stage, S. A., Epstein, M. H., & Pierce, C. D. (2005). The effects of a pre-reading intervention on the literacy skills and social behavior of kindergarten children at risk for behavioral disorders and reading difficulties. *Exceptional Children, 72*, 29–46.

Owens, R. E. (2001). *Language development: An introduction* (5th ed.). Needham Heights, MA: Simon & Schuster Co.

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, instruments, and computers, 36*(4), 717–731.

Reid, R., Gonzalez, J. E., Nordness, P. D., Trout, A., & Epstein, M. H. (2004). A meta-analysis of the academic status of students with emotional/behavioral disturbance. *The Journal of Special Education, 38*(3), 130–143.

Rogers-Adkinson, D. L. (2003). Language processing in children with emotional disorders. *Behavioral Disorders, 29*(1), 43–47.

Schneider, W., & Chein, J. M. (2003). Controlled & automatic processing: Behavior, theory, and biological mechanisms. *Cognitive Science, 27*, 525–559.

Semel, E., Wiig, E. H., & Secord, W. A. (1995). *Clinical evaluation of language fundamentals* (3rd ed.). San Antonio, TX: Harcourt, Brace, Jovanovich.

Shinn, M. R. (2002). Best practices in using curriculum-based measurement in a problem-solving model. In A. Thomas & J. Grimes (Eds.), *Best practices in school psychology IV* (pp. 671–697). Bethesda, MD: National Association of School Psychologists.

Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural equation models. *Sociological Methodology, 13*, 290–312.

Stringer, R. W., Toplak, M. E., & Stanovich, K. E. (2004). Differential relationships between RAN performance, behavior ratings, and executive function measures: Searching for a double dissociation. *Reading and Writing: An Interdisciplinary Journal, 17*, 891–914.

Sunseth, K., & Bowers, P. G. (2002). Rapid naming and phonemic awareness: Contributions to reading, spelling, and orthographic knowledge. *Scientific Studies of Reading, 6*(4), 401–429.

Trout, A. L., Nordness, P. D., Pierce, C. D., & Epstein, M. H. (2003). Research on the academic status of children with emotional and behavioral disorders: A review of the literature from 1961 to 2000. *Journal of Emotional and Behavioral Disorders, 11*, 198–210.

Walker, H. M., & Severson, H. H. (1990). *Systematic screening for behavior disorders* (2nd ed.). Longmont, CO: Sopris West.

Wagner, M. M. (1995). Outcomes for youths with serious emotional disturbance in secondary school and early adulthood. *The Future of Children, 5*, 90–111.

Wechsler, D. (1991). *Wechsler intelligence scale for children* (3rd ed.). San Antonio, TX: Psychological Corp.

Weckerly, J., Wulfeck, B., & Reilly, J. (2001). Verbal fluency deficits in children with specific language impairment: Slow rapid naming or slow to name? *Child Neuropsychology, 7*, 142–153.

Wolf, M., & Bowers, P. G. (1999). The double-deficit hypothesis for the developmental dyslexias. *Journal of Educational Psychology, 91*(3), 415–438.

Wolf, M., Bowers, P., & Biddle, K. (2000). Naming speed processes, timing, and reading: A conceptual review. *Journal of Learning Disabilities, 33*(4), 387–407.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock-Johnson III tests of cognitive abilities and achievement*. Itasca, IL: Riverside Publishing.