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Understanding Interest and Self-Efficacy in the Reading and Writing of Students with Persisting Specific Learning Disabilities during Middle Childhood and Early Adolescence

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Abstract: Three methodological approaches were applied to understand the role of interest and self-efficacy in reading and/or writing in students without and with persisting specific learning disabilities (SLDs) in literacy. For each approach students in grades 4 to 9 completed a survey in which they rated 10 reading items and 10 writing items on a Scale 1 to 5; all items were the same but domain varied. The first approach applied Principal Component Analysis with Varimax Rotation to a sample that varied in specific kinds of literacy achievement. The second approach applied bidirectional multiple regressions in a sample of students with diagnosed SLDs-WL to (a) predict literacy achievement from ratings on interest and self-efficacy survey items; and (b) predict ratings on interest and self-efficacy survey items from literacy achievement. The third approach correlated ratings on the surveys with BOLD activation on an fMRI word reading/spelling task in a brain region associated with approach/avoidance and affect in a sample with diagnosed SLDs-WL. The first approach identified two components for the reading items (each correlated differently with reading skills) and two components for the writing items (each correlated differently with writing skills), but the components were not the same for both domains. Multiple regressions supported predicting interest and self-efficacy ratings from current reading achievement, rather than predicting reading achievement from interest and self-efficacy ratings, but also bidirectional relationships between interest or self-efficacy in writing and writing achievement. The third approach found negative correlations with amygdala connectivity for 2 reading items, but 5 positive and 2 negative correlations with amygdala connectivity for writing items; negative correlations may reflect avoidance and positive correlations approach. Collectively results show the relevance and domain-specificity of interest and self-efficacy in reading and writing for students with persisting SLDs in literacy.

Keywords: *Interest in reading, interest in writing, self-efficacy in reading, self-efficacy in writing, approach/avoidance, amygdala*

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Introduction

Interest and self-efficacy were investigated for two reasons in students during middle childhood and early adolescence (corresponding to upper elementary school and middle school in the country where the research was conducted). First, interest plays a role in what is attended to during instruction at school (Hidi, 1995). As James (1890) observed over a century ago, interest "schools attention". Indeed a recent review of the growing body of research on interest provided evidence for the beneficial impact of interest in focusing learners' attention and providing learners with a basis for meaningful engagement in learning and motivation to succeed (Renninger & Hidi, 2016). Second, as Renninger and Hidi explained, as interest develops, it is increasingly coordinated with feelings of self-efficacy, the belief that one can succeed (e.g., see Eccles, Wigfield, Harold, & Blumenfeld, 1993), especially if the student is also succeeding based on valid assessment measures and that success is effectively communicated with the student.

The current study of interest and self-efficacy draws on the Four-Phase Model of Development of Interest (Hidi & Renninger, 2006; Renninger & Hidi, 2011, 2016). The first phase of interest development involves triggered situational

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interest (piquing attention). The second phase involves maintaining situational interest (sustaining attention). The third phase involves continuing attention that can be voluntary and undertaken independently of others' encouragement or supervision, or emerging individual interest; and the fourth phase involves self-regulation of attention, or well-developed individual interest. Recent research with a comparable sample of students showed that paying attention while listening to or reading language or engaging in the process of producing oral and written language was more predictive of their oral and written literacy skills than was presence or absence of a co-occurring ADHD diagnosis (Berninger, Abbott, Cook, & Nagy, 2016). Interest may be a mediating variable for paying attention to and engaging in language, which in turn influences the developmental journey described by Renninger and Hidi (2016)'s four-phase model of development. The current work also draws on the work of Eccles and colleagues on self-efficacy (e.g., Eccles et al., 1983). Self-efficacy is the learner's beliefs or meta-cognitions about one's readiness to engage successfully in assigned tasks (see discussion in Eccles, Fredricks, & Epstein, 2015). It is likely that learners with SLDs-WL do not believe that they can succeed until their interest and successful achievement have been supported and develop.

Renninger and Hidi (2016) noted that they based their conclusions on review of research specifically focused on typically developing learners. Owens, Goldfine, Evangelista, Hoza, and Kaider (2007) observed in their review of research that learners without disability often described their own competence, or self- efficacy, positively. This tendency is sometimes referred to as positive illusory bias (PIB) if beliefs about one's competence do not correspond with the reality of school performance. Prior research has investigated the relationships of interest and motivation to learn in individuals with Attention Deficit Hyperactivity Disorder (ADHD), without and with other kinds of co-occurring learning differences (e.g., Fink, 2015; Lee & Zentall, 2012; Gut, Heckman, Meyer, Schmid, & Grob, 2012; Hoza, Pelham, Waschbusch, Kipp, & Owens, 2001; Konrad, Gauggel, Manz, &Schöll, 2000; McInerney & Kerns, 2003). However, relatively little research on interest and self-efficacy has focused on students with SLDs-WL, such as dysgraphia (impaired handwriting), dyslexia (impaired word reading/decoding and spelling/encoding), and oral and written language learning disability (OWL LD) (impaired listening and reading comprehension and oral and written expression), as the current study does. Although the OWL LD problems emerge during the preschool years in listening and oral expression and persist during the school years in both oral and written language, they are especially severe in reading comprehension and written expression (Silliman & Berninger, 2011). Collectively, these three SLDs-WL involve difficulties in written language learning (writing and reading) and research is warranted on whether lack of interest may be interfering with their paying attention to instruction regarding written language or engaging in the written language learning activities—not only based on what adults may observe but also from the perspectives of the developing learners themselves.

Also, because each of these SLDs affecting literacy learning involve reading and/or writing the current study examined whether interest and self-efficacy vary as a function of the domain—reading versus writing. To do so an inventory of 10 items was constructed for the reading domain and 10 identical ones for the writing domain; the only difference was the domain in reference to which the participant responded to the statement or question with a rating along a 5-point scale. See Appendix for the items in each domain. These items were constructed based on prior research showing that interest can be measured in reference to a learners' engagement in a particular domain—the frequency and depth of engagement that is voluntary and undertaken independently (Renninger & Wozniak, 1985; Renninger & Hidi, 2016). Providing passages to read on a topic in which there is an existing interest (e.g. skating) can trigger interest, and even perseverance, to read the passage, even if it is a difficult text (Renninger, Ewen, & Lasher, 2002). Yet, interest does not necessarily provide the same kind of support for writing. Just because learners are asked to write about a topic of interest (e.g. outer space) does not guarantee that they have much information about the topic of interest and that in turn can negatively influence their production (Hidi & McLaren, 1990, 1991; see Hidi & Anderson, 1992). Alternatively, learners may have the knowledge, but not have the transcription skills (handwriting and/or spelling) to record their thoughts translated into written language. Three methodological approaches were employed to study the domain-specificity of interest and self-efficacy, as described next.

Identifying components in interest and self-efficacy survey—first methodological approach. To investigate potential components underlying both the reading survey and the writing survey, principal component analysis with varimax rotation was applied to a sample of students without and with SLDs-WL, whose achievement in specific reading skills and specific writing skills fell along a distributed range of reading and writing achievement levels. The research questions were whether the principal components would be related exclusively to interest or self-efficacy as the various items were constructed to reflect and how the identified components for the reading survey would be correlated with specific reading skills on achievement measures and the identified components for the writing survey would be correlated with specific writing skills on achievement measures.

Bidirectional predictions and outcomes for interest and self-efficacy ratings in multiple regressions—second methodological approach. In expectancy value theory for self-efficacy, learners' beliefs are linked to their understanding of the importance of their engagement, their feelings about it, and the costs that it involves (Eccles, Adler, Futterman,

Goff, Kaczala, et al., 1983; Wigfield & Cambria, 2010). Eccles, Wigfield, Harold, and Blumenfeld (1993) reported that elementary school children differentiated self-beliefs for reading, sports, and other domains. More recently, Eccles et al. (2015) suggested that once interest has been triggered and begins to develop, it is at this point that the coordination of interest and self-efficacy might be expected for learners without disabilities.

However, that coordination between interest and self-efficacy may not occur in similar fashion for students with SLDs, especially those that persist in the upper grades despite intervention (supplementary or specialized instruction) during the early grades, whose interests and self-efficacy may be at odds. For example, they may be very interested in expressing their ideas in written stories but develop very low self-efficacy because of repeated lack of success or struggles with transcription (handwriting and spelling) used to record their thoughts in writing. Chronic struggles and even failure in learning to read and/or write may result in lack of interest, despite earlier interest, and negative self-efficacy that one can learn to read and/or write as well as peers even if one exerts as much or more effort. Although teachers sometimes report that students with SLDs are not interested in what is being taught or motivated to learn, it may be that, in contrast they had been interested and motivated, but because they cannot learn despite their best efforts, the lack of achievement results in poor self-efficacy which interferes with future learning due to lack of belief that one can really learn to write (or read).

To sort out whether lack or interest or self-efficacy precedes low achievement or conversely lack of interest or self-efficacy results from low achievement, multiple regressions were performed in both directions. Student ratings of interest and self-efficacy were used to predict literacy achievement in specific skills; and literacy achievement in specific skills was used to predict student ratings of interest and self-efficacy. For these analyses, which only point to possible directions of relationships but not causality apart from other variables, correlations were first obtained between ratings for single items on the survey and test scores on single literacy achievement measures. The statistically significant ones informed how either ratings on surveys or achievement measures were entered into the regressions as predictors and or outcomes.

Amygdala involvement in approach-avoidance gradient for and affect toward reading or writing. Schiefele (1991) made a compelling case for going beyond intrinsic and extrinsic motivation alone in understanding motivation to learn. For example, the role of the amygdala, a brain region situated in the limbic (emotional) brain with connections to cerebral cortex (thinking brain) has been shown to link affect and cognitive variables (Gallagher & Chiba, 1996) in interest and related attention, engagement, motivation, and persistence (Zald, 2003) and on topics with varying perspectives such as politics (Gozzi, Zamboni, Krueger, & Grafman, 2010). For example, amygdala activity has been observed in response to incentives, whereas inferior frontal cortex activity (cognitive) has been observed in goal setting to reach outcomes when there are incentives (Arana**,** Parkinson, Hinton, Holland, Owen, & Roberts, 2003). Moreover the dopamine circuitry that rewards and reinforces interest (Fenker, Frey, Schuetze, Heipertz, Heinze, & Duzel, 2008; Pannakep, 1998) may also influence amygdala activation as the developing learner interacts with the physical and social environment.

Research also suggests that amygdala activity is associated with a variety of emotions including not only negative ones like fear and anxiety (e.g., Stein, Simmons, Feinstein, & Paulus, 2007) but also positive emotions (Hamann, Ely, Grafton, and Kilts, 1999), depending on the side of the brain in which the amygdala is located. Hamann, Ely, Hoffman, and Kilts (2002) studied participants viewing interesting and uninteresting photographs with both positive and negative emotional content. Whereas positive emotional content was associated with left amygdala activity, negative emotional content was associated with bilateral amygdala activation. However, Hamann and Mao (2002) reported that the left amygdala showed more activation for both positive and negative emotional words compared to neutral words. Positive affect may be related to the approach gradient and negative affect related to the avoidance gradient in motivation (cf., Elliot & Covington, 2001). Indeed, a study using text-mining, meta-analysis, and machine-learning techniques based on a very large database identified many more functions for amygdala than only fear and anxiety (Yarkoni, Poldrack, Nichols, Van Essen, & Wager, 2011).

From the perspective of psychology, humans approach what is of interest or is pleasurable to them and avoid what elicits fear or anxiety. Approach, if rewarded with joy or other positive affect, motivates the individual to approach in future and/or engage in the same pleasurable activity in the future. If, however, physical or psychological pain is encountered, then the individual is motivated to avoid and not engage in that activity in the future. Thus, current and past interactions with the learning environment may influence interest, motivation, and engagement in future interactions with the learning environment. Accordingly, the third methodological approach was to correlate individual items on the interest and self-efficacy survey with connectivity with amygdala from seeds (brain regions of interest, RO1's) identified in past research on written words. For reasons just discussed, connectivity with amygdala on both the left and right side of the brain was examined.

Summary of Overall Aims

Currently research on SLDs-WL has focused mainly on the language skills and related processes involved in reading and writing, with relatively little focus on how interest and self-efficacy may play an important role in paying attention to instruction and engaging in learning activities to sustain efforts when faced with learning that is difficult and may lower the self-efficacy of the learner. Whereas interest describes a learner's tendency to approach rather than avoid engagement in particular content or acts (e.g. reading or writing) over time (Renninger & Hidi, 2016), self-efficacy describes a person's beliefs about his or her abilities to engage in that content or those acts needed to sustain future learning. Thus, one research aim was to identify principal components in a survey of interest and self-efficacy in the reading and the writing domains. A second research aim was to investigate whether current achievement levels in reading and writing were related to current interest or self-efficacy ratings or vice versa. In addition, a third research aim was to investigate whether the behavioral ratings for the interest and self-efficacy items on the reading and writing surveys were correlated with brain imaging results to assess the behavioral-biological associations underlying the approach-avoidance gradient in interest relevant to motivation for learning (Elliott & Covington, 2001) and affective responses related to self-efficacy; both may be related to attention, engagement, and motivation for language learning. Each of these research aims required a different methodological approach.

Methods That Informed All Three Methodological Approaches

Participants

*Ascertainment of participants***.** Flyers were distributed in local schools near a research university to announce the opportunity to participate in research on learning to read and write during the upper elementary and middle school grades for both those who had and had not struggled with learning to read and/or write. Interested parents were encouraged to contact the principal investigator who conducted a phone screen to rule out reasons other than SLDs that could explain the continuing struggles of some students. If the results of the phone screen indicated that the student probably did have an SLD or was a typical reader and writer and the parent gave consent and the student gave assent, a comprehensive assessment was scheduled at the university.

The normed measures administered to the student and the questionnaires completed by the parents regarding developmental, medical, and educational history were used to determine whether participating students did or did not have any of the three following SLDs-WL:

1) Dysgraphia (impaired handwriting below – 2SD on at least two handwriting measures and parent reported persisting history of handwriting difficulties despite earlier intervention, but no indicators of reading disability); or

2) Dyslexia (impaired word reading and/or spelling below the population mean and at least one standard deviation below Verbal Comprehension Index, which falls at or above the lower limit of the average range [at or above -2/3 SD or 25th % tile or standard score of 90], and parent reported history of persisting word reading/decoding and spelling/encoding problems despite earlier intervention); or

3) Oral and Written Language Learning Disability (OWL LD) also referred to in the research literature as specific language impairment (SLI) (impaired [below -2/3 SD 25th %tile on two or more measures of listening and reading comprehension and/or oral and written expression, despite earlier intervention] and Verbal Comprehension Index at least within the lower limits of the low average range (at or above -1 1.3 SD or standard score of 80).

See Silliman & Berninger (2011) for review of cross-disciplinary research evidence for the diagnostic criteria for each SLD including contrasting criteria for Verbal Comprehension Index to differentiate those with word-specific reading and spelling problems and syntax level comprehension and expression difficulties among those with reading disabilities.

Interest and Self-Efficacy Measures

Scales for assessing the interest and self-efficacy of learners with and without SLDs-WL were developed for the current study using behavioral indicators identified by Renninger and Wozniak, 1985 (also see Renninger & Hidi, 2016), and self-efficacy items employed in Eccles, Wigfield, Harold, and Blumenfeld (1993). Parallel items for both interest and self-efficacy were constructed for both reading and writing.

Reading Interest and Self-efficacy Inventory (R_ISEI). The R_ISEI uses participants' ratings on a Likert Scale (1 to 5) to assess their interest and self-efficacy for aspects of reading and reading behaviors (see Appendix for items). The coefficient alpha for the items included in this scale was .67.

Writing Interest and Self-Efficacy Inventory (W_ISEI). The W_ISEI is similar to the reading inventory in most aspects except it focuses on writing and writing behavior. Students responded on a Likert Scale (1 to 5). The coefficient alpha for the items included in the scale was .55.

Reading and Writing Achievement Measures

The following reading and writing achievement measures, which were part of the comprehensive assessment battery, were used to investigate the relationship between self-reported interests in reading or writing and achievement on normed measures of reading or writing, respectively, which compare the individual to age or grade peers. The *WJ-III* and *WIAT-III* measures are on a scale with a mean of 100 and standard deviation of 15; and the *TOSWRF, DASH*, and *TOC* measures are on a scale with a mean of 10 and standard deviation of 3.

Altogether six reading measures (accuracy and rate of oral reading of real words and pseudowords, rate of silent word reading, and reading comprehension) were administered, which are described next.

Woodcock-Johnson III (WJ-III) (Woodcock, McGrew, & Mather, 2007). WJ-III subtests *Letter-Word Identification* (reliability .95)*, Word Attack* (reliabilities .73 to .81)*, and Passage Comprehension* (.85) were given to assess two word-level skills and one sentence/text-level skill. *Letter-Word Identification* requires naming letters and reading words aloud from a list, but at the grade levels studied mainly oral reading of real words; it is scored for accuracy. *Word Attack* requires reading aloud pseudowords (pronounceable nonsense words without meaning) in order to test proficiency with decoding—translating unfamiliar written words into spoken words. *Passage Comprehension* requires saying a missing word that has been removed from a sentence or brief paragraph in order to demonstrate reading comprehension of the unfolding text; it is scored for accuracy.

Test of Word Reading Efficiency (TOWRE) (Torgesen, Wagner, & Rashotte, 1999). Two subtests were given that assess the rate of accurate oral word reading (efficiency): *TOWRE Sight Word Efficiency (SWE)* (reliability .91) and *TOWRE Phonemic Decoding Efficiency (PDE)* (reliability .90). *TOWRE SWE* assesses the number of real printed words correctly identified within a 45 second time limit. *TOWRE PDE* measures the number of printed pseudowords that can be said aloud correctly within a 45 second time limit.

Test of Silent Word Reading Fluency (TOSWRF) (Mather, Hammill, Allen, & Roberts, 2004). The *TOSWRF* (reliability .92) requires drawing a line to identify the boundaries for single real written words in rows of letter strings. The time limit is three minutes.

Altogether seven writing achievement measures (three handwriting, two spelling, and two composing) were given, which are described next.

*Alphabet Writing (*Berninger & Wolf, 2009)**.** In this researcher-designed task (interrater reliability .97), participants are asked to write the lower case letters in alphabet order as quickly as they can from memory but so others could recognize them. The score (a raw score converted to a *z*-score based on research norms) is the number of legible letters in order in the first 15 seconds, an index of automaticity in access, retrieval, and production before more controlled strategies are applied.

Detailed Assessment of Handwriting (DASH) (Barnett, Henderson, Scheib, Schulz, 2007). First *DASH Best* was given for which the task is to copy a sentence in one's best handwriting and *DASH Fast* was given second for which the task is to copy a sentence in one's fastest handwriting (interrater reliability .99). Students can choose to use their usual writing—manuscript (unconnected) or cursive (connected) or a combination. The score is based on legibility for single letters within the time limits.

Test of Orthographic Competence (TOC) Word Choice (Mather, Roberts, Hammill, & Allen, 2008). The *TOC Word Choice task* (reliabilities .72 to .75) is to choose which one of the words, which sound like real words when pronounced, is a correctly spelled real word.

WJ III Spelling Sounds (Woodcock et al., 2007). Participants are asked to spell in writing dictated pseudowords. This task (reliability .76) requires both knowledge of alphabetic principle in the spelling direction and orthotactic knowledge of permissible word positions for specific letters or letter groups (Treiman & Kessler, 2014). The score is the total correct.

Wechsler Individual Achievement Test – Third Edition (WIAT-III) Spelling (Pearson, 2009). The task (reliability .92) is to listen to a dictated word alone, then in sentence context, and then alone and then spell that dictated real word in writing.

WJ III Writing Fluency (Woodcock et al., 2001). Participants are given prompts— three words and asked to write a correct sentence using those prompts without altering them in any way (reliability .88). The score is number of correct sentences in 7 minutes.

WIAT III Sentence Combining (Pearson, 2009). The task (reliability .81) is to combine two provided sentences into one well-written sentence that contains all the ideas in the two separate sentences.

Methodological Approach 1: Principal Components with Varimax Rotation Analyses

Participants

Altogether six of the participants qualified as typically developing language learners, 15 met criteria for Dysgraphia, 20 met criteria for Dyslexia, and 10 met criteria for OWL LD. Thus, the sample included individual students who varied as to whether or not they had an SLD and if so the domain of their primary impairment(s) in content subjects of the curriculum (writing and/or reading) and specific skills in those subjects (letter writing, word reading/spelling, or sentence/text comprehension/expression).

The total sample for the principal components analyses consisted of 46 students in grades 4 to 9 who completed both the reading interest and writing interest inventories in addition to the normed measures to identify whether or not they had an SLD and if so the nature of the SLD. Their mean age was 12.1 years (range 9.5-15.9 years, *SD* = 1.3 years). The gender distribution was 33 males (71.7%) and 13 females (28.3%).

The ethnic-racial composition was representative of the region in which the research was conducted: primarily European-American (*n* = 37, 80.04%) but also other ethnicities were self-reported by the parents including European-American/Middle Eastern (*n* = 2, 4.3%), European-American/Hispanic (*n* = 2, 4.3%), Asian-American (*n* = 1, 2.2%), Hispanic (*n* = 1, 2.2%), Caucasian (*n* = 1, 2.2%), European-American/Asian-American (*n* = 1, 2.2%), European-American/Native American (*n* = 1, 2.2%).

Data Analyses

Descriptive statistics (means and standard deviations) were examined for each item on the interest inventories. Correlations between each of the items on the inventories were also analyzed. Then Principal Component Analysis (PCA), which allows for analysis of all of the variance in the empirical associations among items on the inventory (Tabachnick & Fidell, 2013), was used to determine whether any items on the inventories should be eliminated from the scale based on poor loadings or cross loading on multiple components and to construct 2 linear composites of the item responses for reading and 2 linear composites of the item responses for writing. Next, bivariate correlations were computed to determine the relationship between the interest and self-efficacy items on each survey, achievement in reading and writing, and the linear composites based on the PCA analyses. Then analysis of variance (ANOVA) was used to evaluate whether there were statistically significant diagnostic group differences. Finally statistically significant differences between the diagnostic groups on specific interest items in the reading and writing inventories were examined.

Results

*Descriptive statistics for reading interest and self-efficacy inventory scores***.** Participants reported an average total R_ISEI score of 27.3 (*SD* = 10.36). Individual item means and standard deviations, along with correlations among items, are reported in Table 1. Mean ratings on a scale of 1 (low) to 5 (high) ranged from a low of 2.13 for how hard is reading to a high of 4.21 for how important is reading, but most means fell in the range of 3.08 to 3.87 (medium). Correlations, which are also reported in Table 1, show that all the items are significantly correlated with each other except for two— both involving item 4 with items 7 and 10.

Principal Component Analysis (PCA) for Reading Interest and Self-efficacy Inventory (R_ISEI). PCA was performed on the correlations among the items on the reading interest and self-efficacy inventory using SPSS Statistics 19.0 (IBM Corp., 2010). A Varimax rotation was used in order to provide a more easily interpretable result, as well as to minimize negative loadings (Tabachnick & Fidell, 2013). Examination of the scree plot and the eigenvalue greater than one criterion supported two components. The first component had an eigenvalue of 6.04. The second component had an

eigenvalue of 1.26. Together, they account for 72.97% of the total variance. Results for the PCA—R_ISEI are reported in Table 2.

Table 1. Means, Standard Deviations, and Correlations among Items on the Reading Interest and Self-Efficacy Inventory (R-ISEI) Items

Items	1	2	3	4	5	6	7	8	9	10
1. How much fun is reading for you?	-	.793***	.785***	.606***	.636***	.641***	.348*	-.585***	-.615***	.297*
2. How likely are you to do reading that is not assigned?		-	.855***	.659***	.595***	.651***	.461**	-.550***	-.557***	.449**
3. How likely are you to read in your spare time?			-	.724***	.602***	.724***	.460**	-.626***	-.596***	.383**
4. How likely are you to talk about reading with your friends or family outside of work you need to do for class?				-	.361*	.574***	.273	-.302*	-.342*	.171
5. How well do you do in reading?					-	.599***	.606***	-.761***	-.751***	.376*
6. How successful do you think you would be in a career that involved reading?						-	.637***	-.709***	-.481**	.342*
7. How have you been doing on reading assignments this marking period?							-	-.635**	-.488**	.501***
8. In general, how hard is reading for you?								-	.804***	-.397**
9. Compared to other subjects in school, how hard is reading for you?									-	-.346*
10. How important do you think it is to learn to read well?										-
Mean	3.58	3.45	3.11	3.08	3.87	3.42	3.61	2.29	2.130	4.210
Standard Deviation	1.24	1.41	1.5	1.3	1.02	1.15	1.08	1.25	1.190	.870

Note. * p< .05, ** p<.01, and *** p<.001

Table 2. Rotated Principal Component Loadings for Reading Interest and Self-Efficacy Inventory (R-ISEI) Items

Items	Factor 1	Factor 2
1. How much fun is reading for you?	**0.818**	0.345
2. How likely are you to do reading that is not assigned?	**0.824**	0.375
3. How likely are you to read in your spare time?	**0.845**	0.389
4. How likely are you to talk about reading with your friends or family outside of work you need to do for class?	**0.885**	0.063
5. How well do you do in reading?	0.386	**0.767**
6. How successful do you think you would be in a career that involved reading?	**0.596**	**0.574**
7. How have you been doing on reading assignments this marking period?	0.131	**0.853**
8. In general, how hard is reading for you?	-0.364	**-0.827**
9. Compared to other subjects in school, how hard is reading for you?	-0.369	**-0.711**
10. How important do you think it is to learn to read well?	0.128	**0.612**

Note. Factor 1 accounts for 36.722% of variance and
Factor 2 accounts for 36.244% of variance for a total of 72.97%.

One item had a significant (over .40) cross-loading on multiple components. This item was: How successful do you think you would be in a career that involved reading? All other rotated components showed loading above .40 on a single component with no cross loadings over .40 in the second component. Based on analysis of the item content of the rotated components (see items in bold in Table 2), the two components were related to interest (Component 1) or self-efficacy (Component 2).

*Correlations between R_ISEI component scores and reading achievement***.** A significant correlation was found between the Component 1 (interest) score and WJ-III Letter-Word Identification. The Component 2 (self-efficacy) score showed significant correlations with all reading achievement measures in the assessment battery, except for the *TOSWRF*. Results are shown in Table 3.

Table 3. Correlations of Individual R-ISEI Items and Two Component Scores with Reading Achievement Measures.

Items	WJ3 Letter and Word Identifica-tion	TOWRE sight word reading efficiency	WJ3 Word Attack	TOWRE Phonemic Reading Efficiency	Test of Silent Word Reading Fluency	WJ3 Passage Comprehen-sion
1. How much fun is reading for you?	.473**	.402*	.244	.270	.275	.317*
2. How likely are you to do reading that is not assigned?	.463**	.396*	.232	.278	.259	.387*
3. How likely are you to read in your spare time?	.449**	.474**	.261	.309	.186	.326*
4. How likely are you to talk about reading with your friends or family outside of work you need to do for class?	.309	.265	.261	.244	.214	.351*
5. How well do you do in reading?	.478**	.368*	.294	.264	.170	.410**
6. How successful do you think you would be in a career that involved reading?	.395*	.378*	.234	.279	.271	.364*
7. How have you been doing on reading assignments this marking period?	.371*	.426**	.306	.323*	.253	.359*
8. In general, how hard is reading for you?	-.552***	-.572***	-.396*	-.445**	-.252	-.385*
9. Compared to other subjects in school, how hard is reading for you?	-.461**	-.471**	-.335*	-.404**	-.145	-.331*
10. How important do you think it is to learn to read well?	.560***	.395*	.370*	.332*	.312	.243
Component Score for Reading Interest	.334*	0.254	0.201	0.197	0.206	0.315
Component Score for Reading Self Efficacy	.494**	.487**	.361*	.382*	.277	.358*

Note. * p< .05, ** p<.01, and *** p<.001

*Descriptive statistics for writing interest and self-efficacy inventory scores***.** Participants reported an average total W_ISEI score of 32.75 (*SD* = 12.01). Individual item means and standard deviations, along with item correlations, are reported in Table 4. Mean ratings on a scale of 1 to 5 ranged from a low of 1.67 on likelihood of writing in one's spare time to a high of 3.38 on how well one is doing in writing this marking period. The remaining ratings were below 2 (three), 2 to 3 (two), or 3 to 4 (five). Overall, the mean ratings for writing were generally below those for reading. Also, in contrast to the reading ratings, many of the items on the writing inventory were not significantly correlated with each other, as shown in Table 4. Only two items—item 1 (how much fun is writing for you) and item 5 (how well do you do in writing) were correlated significantly with every other item. The first is relevant to interest and item 5 to self-efficacy.

Table 4. Means, Standard Deviations, and Correlations among Items on Writing Interest and Self-Efficacy Inventory (W_ISEI) Items

Items	1	2	3	4	5	6	7	8	9	10
1. How much fun is writing for you?	-	.599***	.677***	.258	.472**	.538***	.360*	.506***	.439**	.410**
2. How likely are you to do writing that is not assigned?		-	.753***	.304*	.192	.454**	.152	-.279	-.335*	.340*
3. How likely are you to write in your spare time?			-	.226	.295*	.470**	.281	-428**	-470**	.318*
4. How likely are you to talk about writing with your friends or family outside of work you need to do for class?				-	.037	.128	-.018	.078	.099	.182
5. How well do you do in writing?					-	.400**	.466**	.521***	.457**	.312*
6. How successful do you think you would be in a career that involved writing?							.250	-.227	-438**	.187
7. How have you been doing on writing assignments this marking period?							-	-479**	-.274	.128
8. In general, how hard is writing for you?								-	.638***	-.164
9. Compared to other subjects in school, how hard is writing for you?									-	-.269
10. How important do you think it is to learn to write well?										-
Mean	2.41	1.87	1.67	1.82	3.15	2.64	3.38	3.33	3.210	3.820
Standard Deviation	1.09	0.98	0.84	0.97	1.09	1.14	0.99	1.06	1.100	1.100

Note. * p< .05, ** p<.01, and *** p<.001

Principal component analysis for writing interest and self-efficacy inventory. PCA was performed on the correlation among the items on the writing interest inventory using SPSS Statistics 19.0 (IBM Corp., 2010). After Varimax rotation, examination of the scree plot and the eigenvalue greater than 1 criterion supported two components. The first component has an eigenvalue of 4.24. The second component has an eigenvalue of 1.58. Together, they accounted for 58.23% of the total variance. Results for this PCA are in Table 5.

Two items had a significant (over .40) cross-loading on multiple components: Item 10 (How important do you think it is to learn to write well?) and Item 1(How much fun is writing for you?). All other rotated components showed loadings above .40 on a single component with no cross loadings over .40 in the second component. Based on the item content, the rotated components reflected interest (component 1) and self-efficacy (component 2), as was found for the reading scale. However, the two rotated components did not account for as much variance in writing interest and self-efficacy as they did for reading interest and self-efficacy.

Table 5. Rotated Principal Component Loadings for Writing Interest and Self-Efficacy Inventory (W_ISEI) Items

Items	Factor 1	Factor 2
1. How much fun is writing for you?	**.730**	**.452**
2. How likely are you to do writing that is not assigned?	**.832**	.122
3. How likely are you to write in your spare time?	**.772**	.366
4. How likely are you to talk about writing with your friends or family outside of work you need to do for class?	**.637**	-.334
5. How well do you do in writing?	.282	**.754**
6. How successful do you think you would be in a career that involved writing?	**.549**	.349
7. How have you been doing on writing assignments this marking period?	.067	**.661**
8. In general, how hard is writing for you?	-.156	**-.845**
9. Compared to other subjects in school, how hard is writing for you?	-.211	**-.747**
10. How important do you think it is to learn to write well?	**.486**	**.435**

Note. Factor 1 accounts for 29.228% of variance and
Factor 2 accounts for 29.004% of variance for a total of 58.232%.

Correlations between W_ISEI components and writing achievement. Bivariate correlations among the two writing interest components and the related writing achievement measures from the assessment battery showed only one significant correlation. The second component (self-efficacy) component score showed significant correlation with *DASH Copy Fast* measure. Results are shown in Table 6.

Given the number of items that were not correlated with other items on the W_ISEI, the hypothesis was tested that the relationship between interest and self-efficacy and writing achievement might be more discernible by examining the correlations between individual items and each of the seven writing achievement measures. Additional correlational analyses shown in Table 6 supported this hypothesis. Item 1 (How much fun is writing for you?) was correlated with the alphabet 15 task, a measure of automatic retrieval of ordered letters from long-term memory, r=.359, p=.017. Item 5 (How well do you do in writing?) was correlated with *DASH Copy Best*, a measure of executive control of quality of handwriting, r=.297, p=.05, and *DASH Copy Fast*, r=.381, p=.011. Item 1 (How much fun is writing for you?), r=.342, p=.023, Item 7 (How have you been doing on writing assignments this marking period?), r=.304, p=.045, and Item 8 (In general, how hard is writing for you?), r=-.347, p=.021, were all correlated with *DASH Copy Fast*. Of interest, was that the latter correlation was negative whereas the first two were positive for the same handwriting achievement measure involving speed.

Likewise three writing inventory items were correlated with spelling measures: Item 7 (How have you been doing on writing assignments this marking period?) with *WJ III Spell Sounds*, r=.300, p=.048, Item 3 (How likely are you to write in your spare time?) with *WIAT III Spelling,* r=.301, p=.047, and Item 7 (How have you been doing on writing assignments this marking period?), r=.410, p=.006.

Table 6. Correlations of Individual W_ISEI Items and Two Component Scores with Writing Achievement Measures.

Items	Alphabet Total Legibility Printed	Copy Sentence Best Writing	Copy Sentence Fastest Writing	WJ 3 Spell Sounds	WIAT3 Spelling	TOC Letter Choice	WIAT3 Sentence Combining	WJ3 Writing Fluency
1. How much fun is writing for you?	.412**	.260	.448**	.007	.190	.077	-.116	-.006
2. How likely are you to do writing that is not assigned?	.258	.121	.167	-.050	.217	.017	.041	-.072
3. How likely are you to write in your spare time?	.190	.174	.273	.068	.315*	.163	.016	.113
4. How likely are you to talk about writing with your friends or family outside of work you need to do for class?	.201	.160	.129	-.005	.028	.037	.141	.027
5. How well do you do in writing?	.044	.283	.402**	.164	.259	.145	-.074	.094
6. How successful do you think you would be in a career that involved writing?	-.027	.151	.234	.183	.180	.028	.183	.134
7. How have you been doing on writing assignments this marking period?	.343*	.165	.150	.248	.322*	.040	.126	.161
8. In general, how hard is writing for you?	-.152	-.179	-.293	.166	.075	.085	.239	.227
9. Compared to other subjects in school, how hard is writing for you?	-.066	-.143	-.290	.020	-.046	.048	.069	.066
10. How important do you think it is to learn to write well?	.255	.292	.306	.088	.144	.165	.176	.120
Component Score for Writing Interest	.091	.188	.326*	.057	.116	.015	-.127	-.027
Component Score for Writing Self-Efficacy	.270	.195	.282	.071	.261	.126	.156	.063

Note. * p< .05, ** p<.01, and *** p<.001

*Main effects for diagnostic groups***.** The results of ANOVAs for main effects for groups for items that statistically differed across the four diagnostic groups in mean ratings are reported in Table 7 for R_ISEI and in Table 8 for W_ISEI. Results for all individual items are available from the first author. Both Tables also provide descriptive statistics (means and standard deviations) for significant group differences. Tables 9 and 10 are organized by specific items. Initially each of the SLD groups is compared to the control group of typical language learners and then each of the SLD groups is compared with each other, two at a time. As shown in Tables 7 and 8, the items on R_ISEI and W_ISEI were sensitive to mean differences in ratings on the two inventories among the diagnostic groups. As shown in Tables 9 and 10, the interest and self-efficacy items on the R_ISEI and W_ISEI were sensitive to the differences among the diagnostic groups.

Table 7. Means (M) and Standard Deviations (SD) and significant ANOVA between Different Diagnosis Groups on Reading Interest and Self-Efficacy Inventory (R_ISEI) Items

Item	Typical	Dyslexia	Dysgraphia	OWL-LD	F(df) p value
How well do you do in reading?	M=4.67 (SD=0.52)	M= 3.63 (SD= 1.06)	M= 4.47 (SD=0.83)	M= 3.00 (SD=.063)	F(3,42)=6.03, p=.002
How successful do you think you would be in a career that involved reading?	M-4.17 (SD=0.98)	M= 3.47 (SD= 1.12)	M= 3.67 (SD=1.17)	M= 2.33 (SD=.052)	F(3,42)=3.26, p=.031
How have you been doing on reading assignments this marking period?	M=4.83 (SD=0.48)	M= 3.63 (SD= 0.83)	M= 3.93(SD=1.22)	M= 2.50 (SD=.054)	F(3,42)=6.74, p=.001
In general, how hard is reading for you?	M=1.50 (SD=0.84)	M= 2.44 (SD= 1.29)	M= 1.53 (SD=0.74)	M= 3.50 (SD=1.05)	F(3,41)=6.27, p=.001
How important do you think it is to learn to read well	M=4.67 (SD=0.52)	M= 4.32 (SD= 0.67)	M= 4.47 (SD=0.83)	M= 3.33 (SD=1.03)	F(3,42)=3.90, p=.015

Table 8. Means (M) and Standard Deviations (SD) and significant ANOVA between Different Diagnosis Groups on Writing Interest and Self-Efficacy Inventory (W_ISEI) Items

Item	Typical	Dyslexia	Dysgraphia	OWL-LD	F(df) p value
How have you been doing on writing assignments this marking period?	M=4.83 (SD=0.41)	M= 3.30 (SD= 0.86)	M= 3.87 (SD=0.92)	M= 2.67 (SD=1.03)	F(3,43)=7.69, p=.001
In general, how hard is writing for you?	M=2.17 (SD=0.98)	M= 3.50 (SD= 0.89)	M= 3.27 (SD=1.28)	M= 2.67 (SD=0.82)	F(3,43)=3.06, p=.038

Table 9. Statistically Significant Pairwise Comparisons of Typically Developing Controls (TD) with SLD groups and SLD groups with Each Other on Specific Reading Interest and Self Efficacy (R_ISEI) Items

Reading Interest Item	Group	N	p-value
How well do you do in reading?	TD	6	0.047
	Dyslexia	20	
How have you been doing on reading assignments this marking period?	TD	6	0.005
	Dyslexia	20	
How well do you do in reading?	TD	6	0.001
	OWL LD	6	
How successful do you think you would be in a career that involved reading?	TD	6	0.002
	OWL LD	6	
How have you been doing on reading assignments this marking period?	TD	6	0.001
	OWL LD	6	
In general, how hard is reading for you?	TD	6	0.004
	OWL LD	6	
How important do you think it is to learn to read well?	TD	6	0.018
	OWL LD	6	
How well do you do in reading?	Dysgraphia	14	0.043
	Dyslexia	20	
In general, how hard is reading for you?	Dysgraphia	14	0.049
	Dyslexia	20	
How well do you do in reading?	Dysgraphia	14	0.002
	OWL LD	6	
How successful do you think you would be in a career that involved reading?	Dysgraphia	14	0.023
	OWL LD	6	
How have you been doing on reading assignments this marking period?	Dysgraphia	14	0.02
	OWL LD	6	
In general, how hard is reading for you?	Dysgraphia	14	0.001
	OWL LD	6	
Compared to other subjects in school, how hard is reading for you?	Dysgraphia	14	0.041
	OWL LD	6	
How important do you think it is to learn to read well?	Dysgraphia	14	0.023
	OWL LD	6	
How successful do you think you would be in a career that involved reading?	Dyslexia	20	0.02
	OWL LD	6	
How have you been doing on reading assignments this marking period?	Dyslexia	20	0.004
	OWL LD	6	
How important do you think it is to learn to read well?	Dyslexia	20	0.008
	OWL LD	6	

Table 10. Statistically Significant Pairwise Comparisons of Typically Developing Controls (TD) with SLD groups and SLD groups with Each Other on Specific Writing Interest and Self Efficacy Inventory (W_ISEI) Items

Writing Interest Item	Group	N	p-value
How have you been doing on writing assignments this marking period?	TD	6	0.014
	Dysgraphia	13	
How have you been doing on writing assignments this marking period?	TD	6	0.001
	Dyslexia	21	
In General, how hard is writing for you?	TD	6	0.003
	Dyslexia	21	
How have you been doing on writing assignments this marking period?	TD	6	0.001
	OWL LD	6	
How much fun is writing for you?	Dysgraphia	14	0.016
	OWL LD	6	

Table 10. Continued

Writing Interest Item	Group	N	p-value
How have you been doing on writing assignments this marking period?	Dysgraphia	14	0.024
	OWL LD	6	
How much fun is writing for you?	Dyslexia	21	0.013
	OWL LD	6	
How likely are you to write in your spare time?	Dyslexia	21	0.04
	OWL LD	6	
In General, how hard is writing for you?	Dyslexia	21	0.042
	OWL LD	6	

Discussion

The principal component analyses results for R_ISEI and W_ISEI identified two components underlying interest items on each inventory. However, although the composite scores for reading interest and reading self-efficacy were correlated with reading achievement measures, they were correlated with different reading achievement measures ; and the component scores for writing interest and self-efficacy were either not correlated with writing achievement measures or with only one writing measure. Comparison of these results further suggests that the relationships between interest and self-efficacy and achievement may not be captured at the level of component scores for writing as it was for reading. Rather, although individual items on the writing inventory were not correlated with each other, individual items on the writing inventory, related to both interest and self-efficacy, were correlated with achievement measures in transcription (handwriting and spelling) but not translation (composing—turning thoughts into language). Clearly, interest and self-efficacy are domain-specific for the domains of reading and writing.

Also relevant to the construct validity of the inventories is that they were sensitive to identifying interest and self-efficacy variables across individual students who differed as to the nature of their SLD—impaired handwriting, impaired word reading/decoding and spelling/encoding, or impaired listening/reading comprehension and oral/written expression—or absence of an SLD-WL. That is, interest and self-efficacy in written language learning showed individual differences within and across carefully diagnosed language learning profiles related to written language learning, even in a relatively small sample.

Methodological Approach 2: Bidirectional Regressions

Participants

For the second methodological approach only data from students who had been recruited in the same way as in the first methodological approach and met criteria for SLD-WL were analyzed. For the correlations between items on the reading interest and self-efficacy survey and reading achievement, complete data for 37 participants with SLDs-WL were available for analyses. For the correlations between items on the writing interest and self-efficacy survey and writing achievement, complete data for 38 participants with SLDs-WL were available for analyses.

Methods

In contrast to the first methodological approach that identified components underlying items on each of the surveys and correlated them with reading or writing achievement, the second methodological approach examined correlations between individual items on the reading or writing survey and scores on achievement measures in the same domain (reading or writing). The purpose of these correlations was to identify the significant ones to use in subsequent multiple regressions to determine if the relationships between interest/self-efficacy and reading/writing achievement are the same regardless of which is entered as the predictors and which is the outcome for multiple regressions with domain (reading or writing) held constant.

Results

The magnitudes and *p*-values for correlations that were significant are summarized in the Appendix (see II for reading and III for writing). At least one correlation between a rating related to interest or self-efficacy with achievement was significant for each of the ten items on the reading survey, but only with five of the ten items on the writing survey. In some cases a correlation was significant for the parallel item on the reading and writing survey but not always. Importantly, the correlations involving the items on the reading survey varied as to whether they were with achievement in oral reading and accuracy for real words (which may be familiar) or for pseudowords (decoding unfamiliar pronounceable nonwords without meaning) or reading comprehension. However, correlations involving the items on the writing survey were always with transcription skills (always handwriting but in one case with spelling)

and never with translation of ideas into writing (composing). Some of the differences in component structure for the reading and writing surveys found in the first methodological approach may be related to interest and self-efficacy in reading being related to achievement across reading skills at all levels of language (subword, word, syntax/text), whereas interest and self-efficacy in writing being related only to transcription skills (mainly handwriting but in one instance spelling) in students with SLDs-WL. The results of these correlations were used to design the multiple regressions that followed.

Table 11. Regressions for Interest and Self-Efficacy Predictors and Reading and Writing Achievement Outcomes and for Reading and Writing Achievement Predictors and Interest and Self-Efficacy Outcomes

Predictors	**Adjusted R^2**	***F***	**df**	***p***	**Beta**	***t***	***p***
READING							
Regression 1 for *WJ3 Passage Comprehension*							
	.119	2.62	3, 33	.07			
How well do you do in reading?					.238	1.26	.22
How likely are you to do reading that is not assigned?					.108	.46	.65
How likely are you to talk about reading with your friends or family outside of work you need to do for class?					.193	.94	.35
Regression 2 for "In general how hard is reading for you?"							
	.177	4.87	2, 34	.01			
WJ 3 Word Identification					-.533	-2.99	.005
WJ3 Passage Comprehension					.008	.05	.96
Regression 3 for "In general how hard is reading for you?"							
	.23	3.60	4, 31	.02			
WJ 3 Word Identification					-.466	-1.72	.10
WJ3 Word Attack					.046	.17	.87
TOWRE Sight					-.331	-1.28	.21
TOWRE Phonemic					.191	.63	.53
Regression 4 for "How well do you do in reading?"							
	.17	4.64	2, 34	.02			
WJ 3 Word Identification					.35	1.89	.07
WJ3 Passage Comprehension					.17	.94	.36
WRITING							
Regression 5 for Alphabet 15							
	.157	4.35	2, 34	.02			
"How likely are you to write in your spare time?"					-.081	-.42	.678
"How much fun is writing for you?"					.496	2.57	.02
Regression 6 for Copy Fast							
	.179	5.05	2, 35	.01			
"How likely are you to write in your spare time?"					.144	.77	.45
"How much fun is writing for you?"					.371	1.98	.06
Regression 7 for WIAT 3 Spelling							
	.089	2.80	2, 35	.07			
"How likely are you to write in your spare time?"					.424	2.14	.039
"How much fun is writing for you?"					-.100	-5.04	.62
Regression 8 for Copy Fast							
	.114	2.59	3, 34	.07			
"Compared to other subjects in school, how hard is writing for you?"					-.208	-.91	.37
"In general how hard is writing for you?"					-.030	-.12	.91
"How well do you do in writing?"					.270	1.40	17
Regression 9 for "How much fun is writing for you?"							
	.218	4.62	3, 36	.008			
Copy Fast					.344	2.23	.03
Alphabet					15 .299	1.99	.055
WIAT 3 Spelling .012 .084 .93							
Regression 10 for "How likely are you to write in your spare time?							
	.140	2.95	3, 33	.047			
Copy Fast					.275	1.66	.11
Alphabet					15 .063	.377	.71
WIAT 3 Spelling					.269	1.64	.11

Table 11 continued

Predictors	Adjusted R^2	*F*	df	*p*	Beta	*t*	*p*
Regression 11 for "In general how hard is writing for you?"							
	.061	1.78	3, 33	.17			
Copy Fast					-.364	-2.10	.04
Alphabet 15					-.063	.37	.72
WIAT 3 Spelling					.155	.90	.37
Regression 12 for How well do you do in writing?"							
	.056	1.72	3, 33	.18			
Copy Fast					.374	2.16	.04
Alphabet 15					-.06	-.34	.74
WIAT 3 Spelling					.03	.15	.88
Regression 13 for "Compared to other subjects in school, how hard is writing for you?"							
	.048	1.60	3, 33	.21			
Copy Fast					-.37	-2.12	.04
Alphabet 15					.004	.02	.98
WIAT 3 Spelling .07 .41 .69							
Regression 14 for "How hard is writing for you?"							
	.22	4.43	3, 34	.01			
Copy Fast					-.517	-3.22	.003
WIAT 3 Sentence Combining (2 sentences into 1)	-1.39	.87	.39				
WJ3 Writing Fluency (sentence composing)	.375	2.22	.03				

Multiple regressions for reading. The following items were selected as predictor variables from the reading surveys based on their significant correlations with passage comprehension, the overall goal of reading: How likely are you to do reading that is not assigned? How likely are you to talk about reading with your friends or family outside of work you need to do for class? How well do you do in reading? The first two are related to interest in reading and the last to self-efficacy in reading. As shown in Table 11 for the first regression, in which these reading survey items were the predictors, they did not account for significant variance for reading comprehension as an outcome. However, when reading achievement measures were entered as predictors for each of reading survey items for interest (see second and third regressions in Table 11) or self-efficacy (see fourth regression in Table 11), the multiple regressions were significant. Yet, only for the second regression in which accuracy of single word reading and passage comprehension were entered as predictors, did any predictor explain unique variance in the interest or the self-efficacy outcome; in that regression accuracy of single word reading explained unique variance in "In general how hard is reading for you?" Still, overall it appears that interest or self-efficacy in reading is more likely to be predicted by level of reading achievement than is interest or self-efficacy likely to predict reading achievement.

Multiple regressions for writing. Of the five writing survey items significantly correlated with at least one writing achievement measure, two were with interest items on the writing survey and three were with self-efficacy items on the survey. Two handwriting measures (automatic alphabet letter writing and copy sentence fast) were correlated with the first interest item; and the spelling measure (dictated spelling) and one handwriting measure (copy sentence best) were correlated with the second interest item. Thus, in the fifth and sixth regressions for handwriting and the seventh regression for spelling (see Table 11), the interest items on the writing survey were entered as predictors: "How much fun is writing for you?" and How likely are you to write in your spare time?" Only one writing measure (copy fast) correlated with three self-efficacy items on the writing survey. Thus, in the eighth regression for this handwriting measure as outcome (see Table 8), these three self-efficacy items were entered as predictors: "How well do you do in writing?" "In general how hard is writing for you?" "Compared to other subjects you take in school, how hard is writing for you?"

Then the relationships between interest or self-efficacy on the writing survey items and writing achievement were examined in the other direction with writing achievement measures as predictors and the same interest (ninth and tenth regressions) and self-efficacy items (eleventh, twelfth, and thirteenth regressions) as the outcome measures (see Table 11). However, the same set of predictors was used (copy sentence fast, automatic alphabet writing, and dictated spelling), as had been used in separate analyses for the fifth, sixth, seventh regressions for interest items and eighth regression for self-efficacy items so that results could be compared across directions—whether the same measure is used as a predictor or outcome. In addition, an exploratory analysis was conducted to evaluate whether adding a composing variable as a predictor might contribute to a significant regression or explain unique variance in self-efficacy.

Results of the analyses showed that all three regressions (fifth, sixth, and seventh) in which a transcription writing skill (handwriting or spelling) was an outcome accounted for significant variance when interest items were predictors. In contrast, when transcription skills was an outcome and self-efficacy was the predictor (eighth regression), the regression did not account for significant variance. In the other direction, when interest items were the outcome, the regression with three transcription skills (two handwriting and one spelling)as predictors accounted for significant variance; but only copy fast explained unique variance in one of these ("How much fun is writing?") and automatic alphabet writing was marginally significant in that regression (see ninth regression in Table 11). With only transcription writing skills as predictors, none of the regressions accounted for significant variance in any of the three self-efficacy items. However, when two sentence composing measures were entered as predictors along with copy fast, the regression accounted for significant variance and both the handwriting (copy fast) and one of the composing measures (timed construction of a sentence from three proved words) each explained significant unique variance in the self-efficacy measure "How hard is writing for you?" (see fourteenth regression in Table 11).

Discussion

The bidirectional relationships between reading achievement and interest or self-efficacy and between writing achievement and interest or self-efficacy again contrasted as they had in the first methodological approach. An approach that designs the regression models to evaluate, based on correlations between two variables at a time, used as both predictors and outcomes in multiple regressions yielded these findings. For reading, the relationships were observed in the direction of achievement predicting interest and self-efficacy rather than vice versa. In contrast, for writing, relationships were observed in both directions. Interest, but not self-efficacy, predictors on the writing survey explained unique variance in writing outcomes. "How much fun is writing for you?" explained unique variance in automatic alphabet writing (see regression 5). "How likely are you to write in your spare time?" explained unique variance in dictated spelling (see regression 7). Writing achievement also accounted for significant variance in the regressions for both of these two interest items on the writing survey (see ninth and tenth regressions). For example, copy sentence fast also explained unique variance in "How much fun is writing for you?" (see ninth regression). However, for the self-efficacy items as outcomes none of the regressions accounted for significant variance, unless a composing measure was added as a predictor. Yet, composing alone was not correlated with any of the writing interest or self-efficacy items on the survey, but both fast handwriting and timed sentence composing explained unique variance when entered conjointly into the regression (see fifteenth regression).

Methodological Approach 3: fMRI Connectivity with Amygdala from Written Word ROIs

Participants

Students who met diagnostic criteria for SLDs-WL and completed the surveys of interest and self-efficacy in reading and writing, were right handed, and did not wear braces or other metal that could not be removed before scanning, were invited to participate in a brain imaging study as well. Seventeen of the children (6 with dysgraphia, and 11 with dyslexia) qualified and their parents granted informed consent and the children granted assent to participate in brain imaging. Their brain imaging data were found to be free of movement artifacts and thus judged to be usable.

Methods

Acquisition of fMRI data and connectivity from four seed points(regions of interest, ROIs) with amygdala on spelling task. Each participant received training outside the scanner and completed this task during scanning—production of letter in the blank in a visually displayed letter string to create a correctly spelled word, that is, a task which required handwriting and word-specific spelling skills also related to word reading. During the fMRI writing tasks, a mirror system enabled the participant in the scanner to see the instructions and task on a screen. The task and writing pad recordings were all programmed, timed, and coordinated with the scanner triggers using E-prime and in-house LabView software. There were 6 s of instruction for spelling followed by the spelling task that lasted for 4 min and was self-paced. After visual display 1, the child wrote a letter in the blank to complete the word spelling. When the child lifted the pen off the tablet, visual display 2 appeared and the process repeated for 4 min.

Functional magnetic resonance imaging (fMRI) connectivity scans on a Philips 3 T Achieva scanner (release 3.2.2 with the 32-channel head coil) were used to obtain measures of functional connectivity. The following fMRI series were scanned: fMRI scan with echo-planar gradient echo pulse sequence (single shot): TR/TE 2000/25 ms; Field of view 240 × 240 × 99 mm; slice orientation transverse, acquisition voxel size 3.0 × 3.08 × 3.0 mm; acquisition matrix 80 × 80 × 33; slice thickness 3.0, scan duration13:08 min/s. Functional images were corrected for motion using FSL MCFLIRT (Jenkinson, Bannister, Brady, & Smith, 2002), and then high-pass filtered at sigma = 20.83. Motion scores (as given in the MCFLIRT report) were computed for each participant and average motion score (mean absolute displacement) for each of the groups: control 1.31 ± 1.37 mm, dysgraphic 1.50 ± 1.23 mm, and dyslexic 1.47 ± 1.03 mm. Spikes were

identified and removed using the default parameters in AFNI's 3dDespike. Slice-timing correction was applied with FSL's slicetimer; and spatial smoothing was performed using a 3D Gaussian kernel with FWHM = 4.0 mm. Time series motion parameters and the mean signal for eroded (1 mm in 3D) masks of the lateral ventricles and white matter (derived from running FreeSurfer3s recon- all on the T1-weighted image) were analyzed.

Group maps for fMRI functional connectivity were generated for the task from 4 different seed points (in the left precuneus cortex PCC, in the left temporal-occipital cortex TOC, in the left supramarginal gyrus SMG, or in the left inferior frontal gyrus, IFG Broca's area) with amygdala. fMRI time-series were averaged within regions of interest (ROIs) formed from a 15 mm sphere centered at each seed. The averaged time-series at each ROI was correlated with every voxel throughout the brain to produce functional connectivity correlation maps, converted to *z*-statistics using the Fisher transformation. Individual functional connectivity values from all four seed points were extracted from the co-registered connectivity maps from the following brain region of interest (ROI) amygdala (57 62 26). In other words, for each participant on the spelling task, functional connectivity values were obtained from each seed point with co-activated amygdala, which were used in the statistical correlational analyses. Only functional connectivity magnitude values for amygdala found to be statistically significant (using FSL's randomise for group analysis, *which corrects for multiple voxels comparisons*) were correlated with the items on the R_ISEI or W_ISEI.

Results

Reading interest and the emotional brain. Only two of the reading interest items were significantly correlated with amygdala on a word-specific spelling task that required handwriting. Connectivity from left precuneus with left amgydala was correlated significantly with students' responses (rating scale 1 to 5) for two reading interest items: (a) How much fun is reading for you? (r=-.55, p=.02); and (b) How likely are you to talk about reading with your friends or family the work you need to do for class? (r=-.48, p=.05). For both items in the reading survey, the correlation with amygdala was negative, indicating that the lower the rating on the Likert scale, the higher the connectivity with amgydala. That higher connectivity may indicate that reading is not perceived to be fun or something one would choose to do outside of school activities and assignments**.** That is, connectivity with amygdala appears to be associated with negative affect for reading in students with SLDs-WL.

Writing interest and self-efficacy and the emotional brain. In contrast to the reading interest items, six correlations with amygdala connectivity were significant. Three correlations were significant for "How likely are you to do writing that is not assigned?" (a) from left supramarginal gyrus with right amygdala, r= -.53, p=.03; (b) from left occipital temporal gyrus with left amydala, r=.55, p=.02; and (c) from left occipital temporal gyrus with right amygdala, r=.48. p=.05. The negative correlation for connectivity with right amygdala from supramarginal gyrus may indicate avoidance. The lower the likelihood that one is going to do writing that is not required is associated with greater connectivity with amygdala. Bilateral connectivity with amygdala may indicate negative affect (Hamann et al., 2002) from these seeds associated with processing letters and written words. The positive correlation of "How well do you do in writing?" with connectivity from left precuneus with right amygdala, r=.59, p=.013, may indicate that the more poorly one does in writing the lower the magnitude of connectivity with amygdala due to avoiding it. Both of the correlations for "How important do you think it is to learn to write well?" were positive: From left precuneus with right amygdala, r=.66, p=.004; from left occipital temporal with left amygdala, r=.51, p=.04.

Discussion

As the connectivity with amygdala shows, the emotional brain appears to be related to interest in reading and interest in and self-efficacy about writing in students with SLDs-WL. In some cases, depending on whether the correlation is positive or negative and the item is about interest or self-efficacy, the amygdala connectivity may reflect approach or avoidance. Whether the connectivity with amygdala is solely on the left or right or bilateral may indicate whether affect elicited by a reading or writing item may be positive or negative affect.

Overview of the Three Methodological Approaches and Conclusions

Overview of Findings

The principal component analyses (first methodological approach) identified two components underlying both the 10-item reading inventory and the 10-item writing inventory on which the items were matched except for domains (reading or writing). The first was related to interest and the second to self-efficacy on both inventories. However, contrasting patterns of correlations were observed between each of the reading interest/self-efficacy components and the reading or writing achievement measures. The reading interest component was related to one reading achievement measure; and the reading self-efficacy component was related to five of the six reading achievement measures—those in which the student had to provide an oral, publically visible response but not the silent word reading measure. The

writing interest component was not correlated with any of the seven writing achievement measures, possibly because even when a developing writer is interested in a topic for a written assignment, other skills such as transcription (handwriting and spelling) may influence whether ideas can be translated into written language. Also, the writing self-efficacy component was correlated with only one writing achievement measure and that was related to speed of handwriting, a transcription skill.

However, when the items on the writing interest survey were analyzed at the individual item level (second methodological approach), rather than at the component level, significant correlations were found between interest items on the writing survey and writing achievement, especially for transcriptions skills (fast handwriting, but also automatic alphabet writing and spelling in some cases). The individual item analyses also enabled comparisons of direction of relationships with interest or self-efficacy in reading or writing and reading or writing achievement, respectively: interest or self-efficacy predicting reading or writing achievement and conversely reading or writing achievement predicting interest or self-efficacy. Whereas reading achievement was more predictive of interest or self-efficacy in reading than conversely in other directions, bidirectional relationships were observed for writing with interest or self-efficacy predicting achievement or vice versa with achievement predicting interest or self-efficacy.

The correlations between the interest and self-efficacy inventory and fMRI connectivity with amygdala (third methodological approach) found that more of the individual items on the writing survey were correlated significantly with brain connectivity with amygdala than were the individual items on the reading survey. Observed correlations were both positive and negative suggesting both approach and avoidance, respectively, and involved connectivity with left or right or bilateral amygdala, suggesting both positive and negative affect. These findings were based on an fMRI word-specific spelling task, which at a behavioral level has been shown to underlie word reading as well as word spelling (Bowers, & Wolf, 1993).

To summarize, during middle childhood and adolescence, the relationships between interest and self-efficacy for reading and writing may contrast in interesting and important ways. Underlying components may capture those relationships for reading, whereas individual items do for writing, at least for transcription skills (handwriting and spelling), both at the behavioral level and the brain levels of analysis. For example, whether or not a developing writer has the necessary skills to produce letters legibly and quickly and spell words so that others can recognize them may affect whether he or she finds writing interesting and/or develops a sense of self-efficacy for ability to express thoughts in writing to communicate with others. In contrast, a developing reader may be interested in reading if he or she can accurately translate real written words into spoken pronunciations (i.e., identify written words), but self-efficacy is related to the accuracy and rate of decoding pronounceable written words without meaning, rate of pronouncing real words, and reading comprehension of sentences/text.

Significance of the Research Findings and Future Research Directions

Cross-disciplinary. The results of the current study do not address causality between the Interest Inventories and either literacy achievement or brain connectivity with amygdala. However, what has been observed from the perspectives of interdisciplinary research might inform future interdisciplinary studies designed to investigate related causal mechanisms. Moreover, interest and self-efficacy are not purely cognitive nor purely emotional variables or understood only from a behavioral or brain basis, but rather draw on interrelationships between cognition (interest) and emotion or metacognition (self-efficacy) in behavior and brain, all of which may exert influences on literacy achievement and vice versa.

Relevance to clinical and educational practice. In an era when evidence-based practices have focused on cognitive, language, and neuropsychological assessment measures and explicit instruction in written language, the contributions of interest and self-efficacy to written language learning have received less attention. Likewise, research on interest and self-efficacy has focused more on typical learners than those with SLDs-WL, as the current study did. In future research on SLDs-WL both clinicians who assess and practitioners who teach should be mindful that (a) skill level in identification of words and comprehension of sentences and text or transcription (handwriting and spelling) in writing may affect interest and self-efficacy variables, which in turn affect motivation to sustain engagement in written language learning; and (b) interest and self-efficacy can mediate response to explicit instruction. For example, consider how the four-phased interest development model (Renninger & Hidi, 2016) is relevant to written language instruction for both those with and without SLDs-WL.

At phase 1 interest can be used to capture learners' attention with themes throughout lesson sets that build on the life of famous people who have overcome struggles to make important contributions to society and service as inspiration to developing readers and writers. For examples of such themes used in studies with students with SLDs-WL, see the stories of Albert Einstein, Mark Twain, John Muir, and Sequoyah in readers' and writers' workshops (Berninger et al., 2008; Berninger & Wolf, 2009). At phase 2 teachers can use interest in content domains like science to sustain attention

and develop deep intellectual engagement (Pugh, Linnenbrink-Garcia, Koskey, Stewart, & Manzey, 2010) through hands-on science problem solving activities (e.g., Berninger et al., 2008). In the process developing readers and writers acquire self-efficacy that they can use written language to learn across the content areas of the curriculum—using written language to learn math, science, and social studies.

Ultimately, during the transition to becoming a self-regulated learner during phase 3, an individual student's interests emerge, which may be different from those of classmates but play an increasing role in that individual's learning and sense of self-efficacy. To facilitate phase 3 development, educators can supplement explicit instruction in written language skills for the group with ample encouragement for reading widely on topics of interest and writing in one's preferred genre(s) ranging from personal narrative to various kinds of fiction (adventure, historical, science) to opinion essays to class or school newspapers to poetry (e.g., Fink, 2015) . The goal is to develop personal pleasure in reading and writing so that the individual continues to engage in reading and writing out of school as well as in school. Finally, during phase 4 individual students' well- developed interests and self-efficacy guide their life-long learning and career choices as literacy and other skills acquired in formal education are translated into practice and daily living.

Nolen (2007a, b) compared two elementary classrooms. In the first the teacher emphasized writing as a social process of communicating and sharing (all students took turns being readers and writers and thinking with each other about their writing) and provided with multiple triggers for developing an interest in writing. In the second traditional classroom the teacher supported students through explicit writing instruction. Not surprisingly, the first approach was more effective. Future research will hopefully generate additional knowledge about effective ways to draw on individuals' interests and self-efficacy in delivery of explicit instruction, along with social interaction among readers and writers, to facilitate the literacy achievement of students with and without SLDs-WL.

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Appendix (Parts I, II, and III)

I Interest and Self-Efficacy Inventory

Instructions: Answer each question by circling a number (1, 2, 3, 4, or 5) that indicates where your answer falls on a scale 1 to 5, ranging from "*No fun…Tons of fun", "Not at all likely….Very likely", "Not well at all…Very well", "Not successful at all…Very successful", "Not hard at all…Very hard",* and *"Not important at all…Very important"*.

Reading Items included the following (first four related to interest and the last six related to self-efficacy):

How much fun is reading for you?

How likely are you to do reading that is not assigned?

How likely are you to read in your spare time?

How likely are you to talk about reading with your friends or family outside of work you need to do for class?

How well do you do in reading?

How successful do you think you would be in a career that involved reading?

How have you been doing on reading assignments this marking period?

In general, how hard is reading for you?

Compared to other subjects you take in school, how hard is reading you?

How important do you think it is to learn to read well?

Writing Items included the following (the first four related to interest and the last six related to self-efficacy):

How much fun is writing for you?

How likely are you to do writing that is not assigned?

How likely are you to write in your spare time?

How likely are you to talk about writing with your friends or family outside of work you need to do for class?

How well do you do in writing?

How successful do you think you would be in a career that involved writing?

How have you been doing on writing assignments this marking period?

In general, how hard is writing for you?

Compared to other subjects you take in school, how hard is writing for you?

How important do you think it is to learn to write well?

II Correlations of Items in Reading Survey with Reading Achievement

Reading Items correlated with a normed measure of reading:

How much fun is reading for you?

For *WJ3 Word Identification*, *r*=.454, p=.005. For *TOWRE Sight*, *r*=.409, p=.012.

How likely are you to do reading that is not assigned?

For *WJ3 Passage Comprehension*, *r*=.368, *p*=.025.

For *WJ3 Word Identification*, *r*=.450, *p*=.005. For *TOWRE Sight*, *r*=.375, *p*=.022.

How likely are you to read in your spare time?

For *WJ3 Word Identification*, *r*=.397, *p*=.016. For *TOWRE Sight*, *r*=.421, *p*=.011.

How likely are you to talk about reading with your friends or family outside of work you need to do for class?

For *WJ3 Passage Comprehension*, *r*=.342, *p*=.038.

How well do you do in reading?

For *WJ 3 Word Identification*, *r*=.440, *p*=.006.

For *WJ3 Passage Comprehension*, *r*=.363, *p*=.027.

How successful do you think you would be in a career that involved reading?

For *WJ 3 Word Identification*, *r*=.334, *p*=.043.

How have you been doing on reading assignments this marking period?

For *TOWRE Sight*, *r*=.335, *p*=.043.

In general, how hard is reading for you?

For *WJ 3 Word Attack*, *r*= -.385, *p*=.02. For *TOWRE Phonemic*, *r*= -.394, *p*=.017.

For *WJ 3 Word Identification*, *r*= -.529, p=.001. For *TOWRE Sight*, *r*= -.493, *p*=.002.

Compared to other subjects you take in school, how hard is reading you?

For *TOWRE Phonemic*, *r*=-.359, *p*=.029.

For *WJ 3 Word Identification*, *r*= -.419, *p*=.01. For *TOWRE Sight*, *r*= -.417, *p*=.01.

How important do you think it is to learn to read well?

For *TOWRE Phonemic*, *r*=.356, *p*=.031.

For *WJ 3 Word Identification*, *r*=.543, *p*=.001. For *TOWRE Sight*, *r* =.370, *p*=.033.

III Correlations of Items in Writing Survey with Writing Achievement

Writing Items correlated with normed measures of writing:

How much fun is writing for you?

For *Alph 15*, *r*=.447, *p*=.006. For *Copy Fast*, *r*=.459, *p*=.004.

How likely are you to do writing that is not assigned? none

How likely are you to write in your spare time?

For *Copy Fast, r*=.370, *p*=.022.

For *WIAT III Spelling*, *r*=.363, *p*=.025.

How likely are you to talk about writing with your friends or family outside of work you need to do for class? none

How well do you do in writing?

For *Copy Fast*, *r*=.38, *p*=.019.

How successful do you think you would be in a career that involved writing? none

How have you been doing on writing assignments this marking period? none

In general, how hard is writing for you?

For *Copy Fast*, *r*= -.345, *p*=.034.

Compared to other subjects you take in school, how hard is writing for you?

For *Copy Fast*, *r*= -.349, *p*=-.031.

How important do you think it is to learn to write well? none