Case Studies Comparing Learning Profiles and Response to Instruction in Autism Spectrum Disorder and Oral and Written Language Learning Disability at Transition to High School

Matthew C. Zajic, Michael Dunn, and Virginia W. Berninger

This study investigated literacy learning in students with specific kinds of language challenges at a specific stage of schooling—transition to high school—when the language requirements of the curriculum can be especially challenging. For this exploratory research, a case study approach was adopted that compared 2 adolescent boys both with language learning problems but with 2 contrasting disabilities—autism spectrum disorder (ASD) versus oral and written language learning disability (OWL LD)—just before entry to ninth grade. Three research aims compared participants on (a) learning profiles assessed via a comprehensive psychoeducational assessment battery, (b) change in their learning profiles based on response to instruction to a computerized intervention, and (c) change in their personal narrative compositions and use of taught translation strategies collected during 6 lessons of the computerized intervention. Results indicated that participants demonstrated variable psychoeducational profiles and response to instruction that highlighted similar yet distinct patterns of strengths and weaknesses. Personal narrative writing samples showed that participants demonstrated distinct challenges, but only the participant with ASD showed no response to instruction and produced predominantly off-topic text. Results are discussed in reference to educational applications and future research design implications to understand the writing challenges experienced by children with ASD in reference to children with OWL LD or other specific learning disabilities. **Key words:** *assessment, autism spectrum disorder, case study, education, intervention, specific learning disabilities, transcription, translation, writing*

Author Affiliations: Curry School of Education and Human Development, University of Virginia, Charlottesville (Dr Zajic); College of Education, Washington State University Vancouver (Dr Dunn); and College of Education, University of Washington, Seattle (Dr Berninger).

Corresponding Author: Matthew C. Zajic, PhD, Curriculum, Instruction and Special Education, University of Virginia, PO Box 400273, Charlottesville, VA 22904 (mcz3e@virginia.edu).

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LITERACY LEARNING DRAWS on aural language by ear, oral language by mouth, reading visible language by eye, and writing language by pen, pencil, or computer tool (Berninger, 2000). Yet, the importance of including writing instruction for language by hand is often ignored or neglected at a time in education when the importance of reading has been emphasized even though writing is equally important (National Commission on Writing for America's Families, Schools, and Colleges, 2003). Moreover, research has shown the benefits of teaching in a manner that integrates language by ear, mouth, eye, and hand and aims at all levels of language of increasing size (subword → word → syntax → text) within each of these language systems close in time (see Berninger, 2015). Thus, the purpose of the research described in this article was to investigate literacy learning in students with specific kinds of language challenges at a specific stage of schooling—transition to high school—when the language requirements of the curriculum can be especially challenging. For this exploratory research, a case study approach was adopted that compared two adolescent boys both with language learning problems but with two contrasting disabilities—autism spectrum disorder (ASD) versus oral and written language learning disability (OWL LD)— just before entry to ninth grade. To begin, the language learning issues associated with each of these disabilities are explained. Then, the research aims are described within the language learning framework for multiple, multileveled language systems that also interact with other domains of development— cognitive, social emotional, sensorimotor, and attention/executive functions.

AUTISM SPECTRUM DISORDER

Autism spectrum disorder is a neurodevelopmental disability in which individuals demonstrate specific difficulties with social communication and social interactions along with presenting restricted, repetitive patterns of behavior, interests, or activities (American Psychiatric Association [APA], 2013). Autism spectrum disorder affects approximately one in 59 eight-year-old children, with an estimated majority (69%) of these children demonstrating below average to above average cognitive abilities without the presence of a co-occurring intellectual disability (Baio et al., 2018). Research has shown that various associated characteristics of ASD may impact academic learning, including variations in social (e.g., social communication and social cognition), cognitive (e.g., executive functions and detail-focused processing), memory, and linguistic (e.g., semantics and pragmatics) abilities (Bauminger-Zviely, 2013, 2014; Fleury et al., 2014; Keen, Webster, & Ridley, 2015; Kim, Paul, Tager-Flusberg, & Lord, 2014; Mundy & Mastergeorge, 2012; Simpson & Myles, 2016; Whitby & Mancil, 2009). Children with ASD demonstrate persistent academic challenges (Bauminger-Zviely, 2013, 2014; Mundy & Mastergeorge, 2012) and represent a substantial percentage (9%) of children receiving school services under the Individuals with Disabilities Education Act in the United States (McFarland et al., 2018).

Language by hand poses special challenges for students with ASD, especially for the transcription and translation processes of writing (Finnegan & Accardo, 2018; Kushki, Chau, & Anagnostou, 2011). Transcription difficulties interfere with turning the language representations in the mind into written letters and words, often due to fine motor control and visual–motor integration that affect handwriting legibility and speed (Church, Alisanski, & Amanullah, 2000; Coffin, Myles, Rogers, & Szakacs, 2016; Kushki et al., 2011; Mayes, Breaux, Calhoun, & Frye, 2017). Translation difficulties interfere with transforming cognitions into language representations in the mind that in turn impact text quality, complexity, and organization (Fayol, Alamargot, & Berninger, 2012); such problems in translation have been associated with problems in cognition, social communication, language, and attention (Brown, Johnson, Smyth, & Oram Cardy, 2014; Dockrell, Ricketts, Charman, & Lindsay, 2014; Mayes & Calhoun,

2003, 2007, 2008; Zajic et al., 2018). However, other multifaceted challenges may underlie the writing difficulties of students with ASD, and research is needed to identify these.

Not only assessment research but also instructional intervention research may be informative in this regard. Evidence-based practices (EBPs) for academic interventions have emerged within the last decade specifically for children with ASD (Bauminger-Zviely, 2013, National Autism Center, 2015; Wong et al., 2015), but EBPs for writing for this population do not exist. Instead, research has suggested drawing from effective writing practices like explicit instruction, technology-aided instruction, self-management, visual supports, and peer-mediated instruction (Asaro-Saddler, 2015, 2016; Pennington & Delano, 2012). However, more research is needed on how best to meet the diverse writing challenges experienced by individuals with ASD.

SPECIFIC LEARNING DISABILITIES

Epidemiological studies have shown that specific learning disabilities (SLDs) related to language affect approximately one in five school-aged children (Katusic, Colligan, Weaver, & Barbaresi, 2009), but not all these SLDs are the same (Berninger & Wolf, 2016; Silliman & Berninger, 2011) as the following examples show. Dysgraphia (impaired subword letter production) interferes with accuracy and/or rate of letter writing, which can in turn interfere with spelling and composing achievement. Dyslexia (impaired word reading and spelling) interferes with learning to decode (pronounce) unfamiliar words, identify familiar real words automatically, and encode (turn heard words into written words). Oral and written language learning disability (impaired listening comprehension, oral expression, reading comprehension, and/or written expression) is related to syntactic and morphological difficulties. So, the hallmark impairment for each of these three SLDs involving language is at a different level of language, and these impairments cascade in increasing unit size (subword→word→sentence→text; Berninger, Richards, & Abbott, 2015). However, although there are cases of pure dysgraphia, pure dyslexia, and pure OWL LD, some students with OWL LD may also have co-occurring dyslexia or dysgraphia, and some students with dyslexia may also have co-occurring dysgraphia. These SLDs affecting language learning at different levels of language occur in students who are otherwise typically developing in terms of cognition, social emotional functions, sensorimotor functions, and attention/executive functions (Berninger, 2015; Berninger et al., 2015).

RESEARCH AIMS OF THE CURRENT STUDY

The *first research aim* is to compare a student with ASD (pseudonym Jack) with a student with OWL LD (pseudonym John) on their learning profiles across the four language systems and various levels of language within language systems as well as cognitive and executive functions. Oral and written language learning disability is typically the most impaired of the SLDs involving language learning—not only are there hallmark impairments in syntax and text language skills but also often challenges with word-level reading and spelling skills. The aural and oral language problems appear during the preschool years and typically continue during the school years (Silliman & Berninger, 2011). Oral and written language learning disability is often confused with dyslexia, but not all reading problems are dyslexia, and OWL LD is often not identified and treated (Arfé, Dockrell, & Berninger, 2014).

Of interest is whether ASD, which involves language as well as nonlanguage impairments, is associated with a similar learning profile for language, cognition, executive functions, and social skills as OWL LD, which is primarily a language impairment. For example, children with ASD and SLD often demonstrate similar problems on writing assessments (Finnegan & Accardo, 2018), but the underlying mechanisms contributing to

these writing problems may differ for the transcription and translation processes of writing (e.g., Price, Lacey, Weaver, & Ogletree, 2017). Transcription difficulties in ASD have been found to be related to graphomotor difficulties (Church et al., 2000; Coffin et al., 2016; Kushki et al., 2011; Mayes et al., 2017), whereas transcription difficulties in dysgraphia, for instance, are related to orthographic coding (storing and processing letter forms in memory) and executive function as well as graphomotor processes (for reviews, see Berninger, 2015; Silliman & Berninger, 2011). Research is needed on whether transcription difficulties in OWL LD are also related to orthographic processes such as the orthographic loop that integrates orthographic codes with graphomotor output and to executive functions that manage the integration process. Translation difficulties are found in both ASD and SLD, but different skills have been shown to predict measures of translation in groups with these contrasting disorders (e.g., ASD symptomatology in children with ASD and working memory and spelling abilities in children with specific language impairment; Dockrell et al., 2014).

In contrast to prior research that examined the predictors of specific written language skills in students with ASD or an SLD, the current study examines the learning profiles of a student with ASD and a student with OWL LD to identify commonalities and differences between them in cognition, the four language systems, and executive functions. Mostly norm-referenced test scores were used for describing these profiles, but occasionally raw scores or *z*-scores based on researcher-developed tasks were used. Parent reports about developmental history prior to school and educational history were also considered for making these comparisons, as well as direct observation by the research team of the students' social behaviors during assessment and instruction.

The *second specific aim* is to compare the student with ASD and the student with OWL LD on response to instruction. These students are matched on grade level after completing intervention (ninth grade at the transition to high school), gender (male), and handedness (right). Both students were Caucasian and came from middle-class families. Of interest is how the component skills in the learning profiles may change in response to the same computerized instruction (either comparably or differently) for the students with contrasting kinds of disabilities involving language. The computerized instructional program teaches writing and reading skills at different levels of language close in time while also drawing on aural and oral language in the process. It has previously been shown to be effective in improving language learning of students with dysgraphia, dyslexia, and OWL LD (e.g., Niedo, Tanimoto, Thompson, Abbott, & Berninger, 2016; Tanimoto, Thompson, Berninger, Nagy, & Abbott, 2015). At issue is whether this intervention designed to teach language learning skills to students with SLD (e.g., OWL LD) will result in comparable response to instruction for a student with ASD. Two kinds of response to instruction assessments are employed: (a) readministration of psychoeducational assessments given at pretest again at posttest to assess changes in specific skills in the learning profile, and (b) writing samples composed by each student in six successive lessons (personal narratives).

The *third specific aim* is to compare response to instruction in writing based on changes in personal narratives over the first six lessons. Specific assessed changes across personal narratives included the percentage of sentences relevant to topic at hand and the frequency of using previously taught strategies for writing the next sentence and creating text structures.

Developmental framework underlying the assessment and instruction

Both assessment approaches and effective instructional practices for children with SLD may also be effective with children with ASD due to common concerns for both populations (Aspy & Grossman, 2016; Price et al., 2017), as both groups can often experience heterogeneous challenges in nonlanguage

domains that further contribute to specific skill difficulties in varied language skills. For example, the nature and the extent of the various difficulties may vary between groups (McKnight & Culotta, 2012; Taylor, Maybery, Grayndler, & Whitehouse, 2014), particularly with regard to specific writing difficulties (for representative findings about the writing challenges of children with SLD, see Arfé et al., 2014; MacArthur, Graham, & Fitzgerald, 2015; Swanson, Harris, & Graham, 2013). Ongoing research is needed to determine how to use effective instructional practices like those used for struggling writers, often with SLD, with children with ASD (e.g., Asaro-Saddler, 2016).

To make the comparisons between ASD and OWL LD in the current study, a developmental framework was adopted on the basis of the four language systems (aural language, oral language, reading, and writing) that function both alone and with each other as well as with cognitive, social–emotional, and attention/executive function processes in guiding language learning and in responding to literacy instruction (Berninger, 2000, 2015; Berninger, Garcia, & Abbott, 2009; James, Jao, & Berninger, 2015). Careful consideration of the overall learning profile with multiple language skills and related processes helps pinpoint where individual strengths and weaknesses fall to inform appropriate instructional approaches (Silliman & Berninger, 2011). The computerized instruction employed in the current study included learning activities that engaged the multiple language systems and were designed to also develop the related processes (see Method section for further discussion).

METHOD

Participants

Student with ASD

Jack was 15 years, 9 months when pretested before participating in the computerized instruction at the university during a summer program, after which he was posttested and entered the ninth grade. While he completed the pretest assessment battery described later, his mother completed parent questionnaires regarding relevant background information about developmental, medical, and educational history. At 4 years of age, Jack was diagnosed with pervasive developmental disorder—not otherwise specified by an interdisciplinary team of medical professionals in the preschool he attended. During the school years, that diagnosis was revised to Asperger's syndrome. With the latest ASD diagnostic criteria revisions (APA, 2013), Jack's diagnosis falls under the broader ASD diagnostic category. He was receiving school services specifically for social skills at the time of the study. It is important to note that an ASD diagnosis rules out a diagnosis of OWL LD, which is diagnosed only in the absence of developmental disabilities. Jack has had a history of sensory problems and sleeping difficulties and takes multiple medications. By parent report, he performs better at reading when he can follow along silently while someone else reads the material aloud to him; he cannot write or read cursive letters but has had prior typing instruction; and he has trouble with note taking at school. His mother also reported that he prefers to read encyclopedias and memorize information; he is particularly interested in fantasy and violence.

During the intervention sessions, the graduate teaching assistants who monitored students' attention to and engagement in the computerized learning activities noted that Jack never interacted socially with any of the other students also participating in the intervention. This lack of social interaction with peers was in marked contrast to the students with SLD who had to be reminded to focus on the learning activities and not to interact with the other students in the computer laboratory at the same time. Jack's data were not included in any previously published research articles by the research team on the effectiveness of the computerized instruction for students with SLD or analyses of diagnostic profiles.

Student with OWL LD

John was 15 years, 6 months when pretested before participating in the computerized instruction at the university during a summer program, after which he was posttested and entered the ninth grade. While he completed the diagnostic assessment battery, his mother completed parent questionnaires regarding relevant background information about developmental, medical, and educational history. Although John produced single words about the time of his first birthday, his multiword constructions were delayed until about the time of his third birthday. His motor developmental milestones were always delayed by a few months during the preschool years. He enjoyed interacting with others but always preferred playing with younger children, possibly because he found it easier to interact with them verbally than same-age peers because of his language challenges. His mother reported that John takes multiple medications, and that he enjoys spending time outdoors, skateboarding, playing with neighborhood children, and going to school. John has always struggled with reading, writing, and math, and has had an Individualized Education Plan since the third grade. An earlier assessment by a neuropsychologist reported diagnoses of attention-deficit/hyperactivity disorder (ADHD), dyslexia, and dysgraphia, all of which were noted in the pretest assessment for the current study in addition to the OWL LD. The neuropsychologist probably did not diagnose OWL LD due to not assessing oral language or not reviewing preschool development history.

Assessment battery

All measures in Table 1 were administered both at pretest and posttest (except for tests of cognition, which were administered only at pretest). The pretest measures were used to describe the overall profiles for cognition, aural and oral language, reading and writing, and executive functions prior to the computerized instruction. The changes from pretest to posttest on the measures given at both times were used to assess response to instruction. A change of at least one-third standard deviation (five points for standard scores and one point for scaled scores) was noted as a probable indicator of improvement (see Tanimoto et al., 2015).

Cognition

A Neuropsychological Assessment, Second Edition (NEPSY-II; Korkman, Kirk, & Kemp, 2007): Theory of Mind. Theory of Mind refers to how well individuals can understand that others may have perspectives different from their own. The verbal task, which is sensitive to the social aspects of communication, requires responding to questions about various scenarios to assess understanding of others' perspectives. The contextual task requires identifying the represented affect of specific people. Publisher-reported test–retest reliability is 0.58.

Woodcock-Johnson III Tests of Cognitive Abilities (WJ-III COG; McGrew & Woodcock, 2001): Concept Formation and *Analysis Synthesis.* The Concept Formation task assesses inductive reasoning (the ability to abstract concepts from examples of the concepts) via identifying the rule governing a set of colored geometric figures. The Analysis Synthesis task assesses deductive reasoning (the ability to apply a concept or a rule to solve a problem) via identifying the missing components of an incomplete logic puzzle. Publisher-reported test–retest reliabilities are 0.77 and 0.83, respectively.

Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV; Wechsler, 2003): Similarities, *Vocabulary*, and *Comprehension.* The Similarities task requires explaining orally how two items spoken by the examiner are alike. The Vocabulary task requires oral definitions of words spoken by the examiner. The Comprehension task requires orally responding to questions about the world we live in. Scores on the three subtests are combined to compute the Verbal Comprehension Index, an indicator

Table 1. Psychoeducational assessment prior to computerized instruction for multilevel integrated reading–writing for a student with autism spectrum disorder (Jack) and a student with oral and written language learning disability—impaired syntax (John)

	Jack's Profile (Autism Spectrum Disorder)		John's Profile (Oral and Written Language Learning Disability)	
	Score	Range[b]	Score	Range[b]
Cognitive[a]				
NEPSY-II Theory of Mind[c]	1-3	Below average	< 2	Below average
WJ-III COG Concept Formation[d]	103	Average	86	Low average
WJ-III COG Analysis Synthesis[d]	51	Below average	95	Average
WISC-IV Verbal Comprehension[d]	83	Low average	77	Borderline
WISC-IV Similarities[e]	7	Low average	5	Borderline
WISC-IV Comprehension[e]	6	Low average	7	Low average
WISC-IV Vocabulary[e]	8	Average	6	Low average
Aural and oral language				
WJ-III ACH Understanding Directions[d]	68	Below average	86	Low average
WJ-III ACH Oral Comprehension[d]	96	Average	105	Average
CELF-4 Formulated Sentences[e]	5	Borderline	5[h]	Borderline
Reading				
WJ-III ACH Word Identification[d]	93	Average	55	Below average
WJ-III ACH Word Attack[d]	92	Average	82	Low average
WJ-III ACH Passage Comprehension[d]	70	Borderline	78	Borderline
TOWRE-2 Sight Word Efficiency[d]	74	Borderline	75	Borderline
TOWRE-2 Phonemic Decoding Efficiency[d]	73	Borderline	73	Borderline
Writing				
Alphabet Keyboarding Letters[f]	19[h]	-	8[h]	-
Alphabet Manuscript Letters[f]	3[h]	-	4[h]	-
Alphabet Cursive Letters[f]	0[h]	-	0[h]	-
DASH Copy Best[e]	5	Borderline	4[h]	Borderline
DASH Copy Fast[e]	3	Below average	4	Borderline
WIAT-III Spelling[d]	78[h]	Borderline	75	Borderline
WIAT-III Sentence Combining[d]	74[h]	Borderline	69[h]	Below average
WJ-III ACH Writing Fluency[d]	78	Borderline	57[h]	Below average
TOC Word Choice[e]	7[h]	Low average	6[h]	Low average
TOC Word Scrambles[e]	4[h]	Borderline	6[h]	Low average
Executive functions				
D-KEFS Color Word Inhibition[e]	1[h]	Below average	2	Below average
RAN Letters[d]	105	Average	101	Average
RAS Letters and Numbers[d]	87	Low average	85[h]	Low average
Alphabet 15 Rapid Automatic Letter Writing Z-Score[g]	−2.50[h]	Below average	−2.48[h]	Below average

Note. CELF-4 = Clinical Evaluation of Language Fundamentals, Fourth Edition; DASH = Detailed Assessment of Speed of Handwriting; D-KEFS = Delis-Kaplan Executive Function System; NEPSY-II = A Neuropsychological Assessment, Second Edition; RAN = Rapid Automatized Naming; RAS = Rapid Alternating Stimulus; TOC = Test of Orthographic Competence; TOWRE-2 = Test of Word Reading Efficiency, Second Edition; WIAT-III = Wechsler Individual Achievement Test, Third Edition; WISC-IV = Wechsler Intelligence Scale for Children, Fourth Edition; WJ-III ACH = Woodcock Johnson Tests of Achievement, Third Edition; WJ-III COG = Woodcock Johnson Tests of Cognitive Abilities, Third Edition.

[a]The cognitive measures were administered only at pretest.
[b]Ranges indicate the band in which scores tend to occur across repeated testing and tend to be more reliable than standard scores, scaled scores, or z-scores alone. Ranges are interpreted as follows: Average = $-2/3$ standard deviation (*SD*) to upper limit just below $+2/3$ *SD*; Low Average = $-1 1/3$ *SD* to upper limit just below $-2/3$ *SD*; Borderline = -2 *SD* to upper limit just below $-1 1/3$ *SD*; and Below Average = below -2 *SD*.
[c]Percentile Score.
[d]Standard Score (mean = 100, *SD* = 15).
[e]Scaled Score (mean = 10, *SD* = 3).
[f]Raw Score.
[g]Z-Score (mean = 0, *SD* = 1).
[h]Participant demonstrated change from pretest to posttest on standard score, scaled score, or z-score of at least $1/3$ of a *SD* (see article text for means and *SDs*) or noticeable change in the positive direction on raw scores. See text for further discussion.

of verbal intelligence. Publisher-reported test–retest reliability for the Verbal Comprehension Index is 0.93–0.95.

Aural and oral language

Woodcock-Johnson III Tests of Achievement (WJ-III ACH; McGrew & Woodcock, 2001): Oral Comprehension and *Understanding Directions.* The Oral Comprehension task is an aural cloze task that requires providing a word orally during a pause in unfolding heard text. The Understanding Directions task assesses how well an individual can understand and follow spoken directions. Publisher-reported test–retest reliabilities are 0.88 and 0.83, respectively.

Clinical Evaluation of Language Fundamentals, Fourth Edition (CELF-4; Semel, Wiig, & Secord, 2003): Formulated Sentences. The Formulated Sentences task requires constructing oral sentences from three provided words. Publisher-reported test–retest reliability is 0.62–0.71.

Reading

WJ-III ACH: Word Identification, *Word Attack*, and *Passage Comprehension.* The Word Identification task requires pronunciation of single real written words on a list without context clues. The Word Attack task requires pronunciation of single written pseudowords (pronounceable words without meaning) on a list. The Passage Comprehension task requires orally supplying a missing word in a blank that fits the context of a current sentence and prior sentences in a written passage. Publisher-reported test–retest reliabilities are 0.95, 0.71–0.83, and 0.85, respectively.

Test of Word Reading Efficiency, Second Edition (TOWRE-2; Torgesen, Wagner, & Rashotte, 2012): Sight Word Efficiency and *Phonemic Decoding Efficiency.* The Sight Word Efficiency task requires accurate pronunciation of as many printed real words on a list as possible within 45 s. The Phonemic Decoding Efficiency task requires accurate pronunciation of as many printed pseudowords on a list as possible

within 45 s. Publisher-reported test–retest reliabilities are 0.91 and 0.90, respectively.

Writing

Alphabet letter writing from memory (first 15 s). This experimenter-designed measure requires individuals to produce lowercase letters of the alphabet accurately and quickly in alphabetic order from memory (Berninger, 2009), first by printing manuscript letters, then by printing cursive letters, and then by selecting keys on a keyboard. Three raw scores are generated for the number of correct letters within the first 15 s in alphabet writing from memory: printing manuscript letters, writing cursive letters, and selecting and pressing letters on a keyboard. The *z*-score for printing manuscript letters in alphabetic order from memory (legible letters in correct order in first 15 s) is used as an indicator of accuracy and automaticity of the orthographic loop (see executive functions; Berninger, 2009).

Detailed Assessment of Speed of Handwriting (DASH; Barnett, Henderson, Scheib, & Shulz, 2007): Copy Best and *Copy Fast.* Both tasks require copying a sentence with all letters of the alphabet. For the Copy Best task, the instructions are to copy the sentence in one's best handwriting. For the Copy Fast task, the instructions are to copy the sentence in one's fastest handwriting. No test–retest reliability is reported, but interrater reliability is 0.99.

Wechsler Individual Achievement Test, Third Edition (WIAT-III; Wechsler, 2009): Spelling and *Sentence Combining.* The Spelling task requires individuals to handwrite the spelling of dictated real words an examiner pronounces alone, within the context of a sentence, and then alone again. The Sentence Combining task requires individuals to combine two provided written sentences into one written sentence that contains all ideas from both separate sentences. Publisher-reported test–retest reliabilities are 0.92 and 0.88, respectively.

WJ-III ACH: Writing Fluency. The Writing Fluency task requires composing written sentences for sets of three provided words. All three words in a set are to be used to create the sentence without changing individual words in any way (e.g., tense, plurality). The time limit is 7 min. Publisher-reported test–retest reliability is 0.81.

Test of Orthographic Competence (TOC; Mather, Roberts, Hammill, & Allen, 2008): Word Choice and Word Scrambles. The Word Choice task requires individuals to identify the correct spelling among choices for a real written word. The Word Scrambles task requires unscrambling letter order to create a correct real word spelling. Publisher-reported test–retest reliability is 0.72–0.75 and 0.88–0.90, respectively.

Executive functions

Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001): Color Word Form Inhibition. The Color Word Form Inhibition task requires individuals to read aloud color words in black ink and then name the color of the ink in a written word that conflicts with the name of the color word (e.g., red ink for the color word green). It is a measure of selective attention for focusing on what is relevant and ignoring what is irrelevant. Publisher-reported test–retest reliability is 0.62–0.76.

Rapid Automatized Naming of Letters (RAN) and Rapid Alternating Stimulus (RAS; Wolf & Denckla, 2005). The Rapid Automatized Naming of Letters, which is timed, requires naming lowercase alphabet letters (not in alphabetic order) arranged in rows as accurately and as quickly as possible. It assesses the phonological loop of working memory. The Rapid Alternating Stimulus task, which is timed, requires naming alternating lowercase printed letters (not in alphabetic order) and numerals (not in counting order) arranged in rows as accurately and as quickly as possible. It assesses switching attention from naming one orthographic stimulus to naming another as is needed when reading and

spelling. Publisher-reported test–retest reliability is 0.90.

Alphabet letter writing from memory (first 15 s)—Printing Manuscript Letters. Alphabet 15 is a measure of the orthographic loop of working memory and is assessed with a measure of rapid automatic letter writing or letter production (Berninger, 2009). See alphabet letter writing from memory (first 15 s) in the writing measures for more information.

Computerized instruction aimed at multiple levels of language close in time

This computerized intervention was based on two decades of interdisciplinary research findings related to human-teacher–delivered instruction grounded in the multileveled view of language and the view that reading and writing are separate skills that can be integrated. All activities required participants to engage with multimodal instructions (listening to the computer teacher and viewing visual stimuli often animated on the computer screen) on a provided iPad device. Participants completed a series of tasks guided by a computer teacher (through earphones, students heard instructional talk synchronized with aural and oral language cues and the visible language cues on monitor for learning activities) that prompted learning activities and provided feedback. Participants had to complete 18 daily sessions, each of which lasted approximately 2–$2\frac{1}{2}$ hr; these were offered four times a week for 6 weeks, allowing some flexibility for summer schedules. Participants progressed through specific learning activities that targeted (a) subword-level handwriting (manuscript and cursive) and related processes, (b) word-level reading and spelling and related processes (grapheme–phoneme correspondences in reading direction and application to reading words; phoneme–grapheme correspondences in spelling direction and application to spelling words; word families; word-specific spellings; and phonological, orthographic, and morphological awareness and integration of phonology, orthography, and morphology),

(c) sentence-level comprehension and composing (word order and function/content word learning activities), and (d) text-level strategies for composing the next sentence and for creating text organization, followed by composing (first six sessions, personal narratives; last 12 sessions, writing notes and summaries based on source material that is read and source material that is heard). Participants proceeded at their own pace until most of the learning activities were completed, but a few of the learning activities (e.g., the text composing) had set time limits. Students received feedback for their performance on the screen for most learning activities and recorded the feedback on a personal growth graph reviewed with a teacher at the end of each session. All tasks were completed using a stylus for handwriting, a finger press for choosing/dragging elements for word- and sentence-learning activities, or a keyboard for typing.

Before composing personal narratives or summaries, students were taught strategies for composing the very next sentence and creating unfolding discourse structure at the text level (for specific strategies taught at Level I for Thinking About Writing the Next Sentence and at Level II for Connecting Sentences Together, see Niedo et al., 2016). Taught strategies were based on strategies observed in the composing of typically developing writers (see Niedo & Berninger, 2016). Strategies were taught by asking participants to click on each one in order for an overview of constructing the very next sentence and connecting sentences together. Participants were then reminded at the beginning of each writing sample that they could access any of these strategies at any time during their composing by clicking a box on the computer screen to review it for applying to the text they were composing. If the participants did not use the fully allotted time, they were encouraged to keep writing until time ran out. For further details about the content and nature of the learning activities, see Tanimoto et al. (2015).

Composing personal narratives

In the current study, the focus is on analyzing the personal narratives across the first six sessions because of the personal and social emotional insights they may provide about writers who struggle with learning for contrasting reasons. The personal narratives that Jack and John composed are presented side by side in Table 2 for comparisons within a session and across sessions. The results for notes and summaries for source material are not presented in this article for these reasons: (a) space limitation prohibits reproduction of source materials for interpreting compositions; and (b) the significant reading comprehension challenges and co-occurring ADHD diagnoses of both boys make it difficult to sort out whether challenges during summary writing were due to writing difficulties or other learning difficulties. Nevertheless, the changes in test scores in learning profiles from pretest to posttest reported in this article are based on the completion of both summary composing and personal narrative writing sessions. For more information on the notes and summaries composing, see Tanimoto et al. (2015).

Participants received the following general instructions before each prompt for a specific kind of autobiographical writing in a given session (your life during school years; your life before starting school; your life after schooling is completed; your family; your country and world; your interests). Note that affixes were called fixes, and participants were taught that fixes can change words so that they fit the grammar and meaning of a sentence.

A writing strategy for story writing is to think with your inside voice. What you think, you "say" silently with your inside voice and you can turn it into sounds, spelling, and base words with and without fixes. That is, you can turn your thoughts into written language!

Then students were reminded that they could click on a link on the screen if they wanted to review strategies they had just

Table 2. Personal narratives written by a student with autism spectrum disorder (Jack) and a student with oral and written language learning disability (John)[a]

	Jack (ASD)	John (OWL-LD)
Lesson 1		
Topic: My autobiography about current life at school	Hi I am J	My da is good
Medium: Stylus		I am probibly going Longboarding when I get home.
Lesson 2		
Topic: Autobiography about life before going to school	Johny Depp [*doodling*]	What I lern today was Before school I was a little bo
Medium: Stylus	The [school district] sucks [*doodling*]	What I did before I was in school was go to the Park
		I like to go on car rides with my
		Before school I like to go on car ride with my mom
		I like to go to to the park
		Before I started school I liket to go to the park and go on car drives.
		My life before school.
		I have always loved swimming
		I swim on [local swimming club]
		we are the reining champions for 8 year
		we have neer lost an A meet in 10 years.
		I also love doing water polo.
		It starts right after swimming season.
		we were undefeated last year.
		I love almost all water sports
		I also am on [specific swim team]
		Its awesome!
		I have lots of fun durring the summer!
		I also go to Boyscout camp in [different state]
		I got the swim First aid, row, art, and wilderness survival

(*continues*)

Table 2. Personal narratives written by a student with autism spectrum disorder (Jack) and a student with oral and written language learning disability (John)[a] *(Continued)*

	Jack (ASD)	John (OWL-LD)
Lesson 3		
Topic: Predictions about life after school	Hi I am a fan of the Nintendo 64	After school ends
Medium: Stylus	List of video game characters that should be in super smas bros.:	After my school years I wanna start a longbo
	[list of characters]	When school ends I whanna start a longboard shop and sell longboards that I make
		I just finished [old school and grade].
		I've been there since kindergarten
		[city] is where I grew up.
		I learned everything I know there.
		I made great friends.
		but now I am going to middle school.
		I am nervouse but excited
		I am going to see all my friends every day.
		This summer I am on swim & waterpolo teams for [specific club]
		We won swim and water Polos still going.
		I am looking forward to Middle school.

(continues)

Table 2. Personal narratives written by a student with autism spectrum disorder (Jack) and a student with oral and written language learning disability (John)[a] (*Continued*)

	Jack (ASD)	John (OWL-LD)
Lesson 4 Topic: My family Medium: Keyboard	List of characters that should all be in super smash bros: -Mario, Luigi, Peach, & Bowser *Super Mario Bros* -Link, Zelda (Shiek), Gannondorf, & Skull Kid *Legend of Zelda* -Kirby, Meta Knight, King Dedede, and Marx *Kirby's* -Yoshi & Kamek *Yoshi's Island* -Samus (Zero Suit Samus) *Metroid* -Fox, Slippy, Falco, & Crystal *Star Fox* -Snake *Metal Gear Solid* -Sonic & Dr. Eggman Super Smash Bros is a game for the N64 made in 1999 it's a fighting style game where everyone is fighting aginst each other (every man for himself). There are 8 characters you start out with: Mario, Donkey Kong, Link, Pikachu, Yoshi, Fox, Kirby and Samus. There also 4 characters you need to unlock they are: Jigglypuff, Ness, Luigi, and Captian Falcon. Plus there are items from other Nintendo games including pokeballs. Along with 11 amazing stages: Peach's Castle, Saffron City, Hyrule Castle, Brinstar, Dream Land, Kongo Jungle, Yoshi's Island, Sector Z, and the locka	when my famly is inside my house they like to play Wii. When my famly is outside my house they like to go flying in my dad plain and they like to play card games on the front porch and they like to ride there bikes and they like to hang out with there frends and they like to walk the dog.

(*continues*)

Table 2. Personal narratives written by a student with autism spectrum disorder (Jack) and a student with oral and written language learning disability (John)[a] (*Continued*)

Jack (ASD)	John (OWL-LD)
Lesson 5	
Topic: My country and my world	
Medium: Keyboard	
Rareware is a company that makes video games. "Rare" is often shortened for Rareware. Rare was founded 1985 by _____. Rare started working with Nintendo making the Donkey Kong Country franchise (not counting Returns). Rare also devloped some shooter games like 007 Goldeneye and Perfect Dark. Though in 2007 Rare stopped working with Nintendo and went over with Microsoft. Rare has made many different game series like: Donkey Kong, Banjoo Kazooie, Conker's, Perfect Dark, and more. The most famous Rare game made in 1994 is Donkey Kong Country for the SNES (Super Nintendo Entertainment System). Also Johny Depp is an amazing actor. He was born June 9, 1963 in Kentucky. His most famous acting is in disney's Pirates of the Caribbean movies as Captain Jack Sparow. He was also in other disney movies like: The Lone Ranger and Alice in Wonderland (2010). His full name is Jonathin Christopher Depp II. He also happens to be a fan favorite actor in most movies that he's in. Also he's been acting since 19__–present. He is still alive today. When he acts he signs his own contract because he's old enough to. Also Johny Depp was in the movie Edward Scizzorhands as Edward. The Pirates of the Caribbean saga has 4 movies: Curse of the Black Pearl (2003), Dead Man's Chest (2006), At World's End (2007), and last On Stranger	My countrey is big. I live in the United States. There is a lote of pepple in my contriey i like my countriey. we have alote of states in my countriey. I live in [current state].
	(continues)

Table 2. Personal narratives written by a student with autism spectrum disorder (Jack) and a student with oral and written language learning disability (John)[a] (*Continued*)

	Jack (ASD)	John (OWL-LD)
Lesson 6 Topic: My interests Medium: Keyboard	Waluigi is a video game character. In the Super Mario Bros series. He made his first apperence in Mario Tennis (N64)(2000). He's a greedy & evil human. He is a crossover of the two characters Wario and Luigi. He also happens to be the partner of Wario. Waluigi is very tall and very skinny so in other words he's the execat opposite, Wario in terms of shape. His realtionship to Wario is unknown. Some say he is Wario's younger or twin brother, others say he's a clone. Rumors say that he has been working in the shadow of the Mario Bros. Waluigi happens to appear as a trophy in Super Smash Bros. Melee as well as Super Smash Bros. Brawl. He also appears as an assist trophy in Brawl, by kicking people and wacking them with his tennis racket. He has been known as Luigi's ultimate rival. Waluigi doesn't get along with Luigi at all. Wario and Waluigi are known as "The two evil guys". Waluigi's first race was in Mario Kart Double Dash (2003). Waluigi's primary color is dark purple. He happens to have elf-like ears and elf-like shoes. His hat happens to have an upside-down "L" on it. Waluigi also plays other sports such as: soccer, basketball, golf, baseball and many more. Wauigi as other rivals besides Luigi such as Princess Daisy (which started in Mario Party 4). His first Mario Party game was Mario Party 3 (2000). Waluigi happens to be alot like Wario. He's Luigi's alterego, just like how Wario is Mario's alterego. Waluigi often scures people in different ways. Plus he happens to wear purple with black overalls. In sports games Waluigi is considerded a Techniche player along with Princess's Peach and Daisy. Waluigi allways has Wario as his default partner in games. Waluigi (wa-lu-igi). In sports games his special powers involve using some sort purple substance's. Waluigi has twig like bones so he has practilly no bone density. Unlike Wario who has too much bone density. His favorite food is eggplant.	My intrestests out side of school is longboarding/ Skateboarding becuse I like to bulid Longboards and I love riding. I love longboarding becuse I like geting speed and. My intrestets in school is history becue im good.

Note. ASD = autism spectrum disorder; OWL-LD = oral and written language learning disability.
[a]All text is shown as produced by Jack and John. No corrections have been made to their texts.

practiced for writing the next sentence and for connecting sentences so that they could apply them to their own writing.

RESULTS

Research aim 1: Learning profiles prior to computerized instruction

Table 1 provides scores from Jack and John on the psychoeducational assessment measures. Their overall performance is discussed in reference to their profiles of cognitive, aural/oral language, reading, writing, and executive function measures.

Cognitive profile

Jack's overall cognitive profile demonstrated variable abilities. However, because all but two of the cognitive skills fell in the normal range, a diagnosis of intellectual disability was not warranted. His verbal cognitive abilities fell in the low average range to average range. His nonverbal reasoning showed a dissociation between inductive reasoning (WISC-IV Concept Formation) in the average range and deductive reasoning (WISC-IV Analysis Synthesis) in the below average range. Consistent with his ASD diagnosis, Jack scored outside the normal range (below average; first to third percentile range) on NEPSY-II Theory of Mind, a measure sensitive to the social cognition challenges associated with ASD (APA, 2013).

John demonstrated variable cognitive abilities, ranging from below average to average. Four of his seven cognitive abilities assessed were in the low average or average range. His verbal cognitive abilities spanned the borderline to low average ranges. For nonverbal abilities, he had a relative strength in deductive reasoning (average range) compared with inductive reasoning (low average range). John scored below average on NEPSY-II Theory of Mind, which can be a noted area of difficulty for children with language learning difficulties (Taylor, Maybery, Grayndler, & Whitehouse, 2015).

Aural and oral language profile

Jack showed a sizable dissociation between the two listening comprehension measures: WJ-III ACH Oral Comprehension was in the average range, but WJ-III ACH Understanding Directions was in the below average range. Likewise, his ability to express his ideas in oral language on the CELF-4 Formulated Sentences was in the borderline range.

John showed a relative strength on one of the two listening comprehension measures: WJ-III ACH Oral Comprehension was in the average range, but WJ-III ACH Understanding Directions was in the low average range. John's ability to express his ideas in oral language on the CELF-4 Formulated Sentences fell in the borderline range.

Reading profile

Jack's accuracy for orally reading real words (WJ-III ACH Word Identification) and pseudowords (WJ-III ACH Word Attack) was in the average range. However, his oral reading rate for single real words (TOWRE-2 Sight Word Efficiency) or pseudowords (TOWRE-2 Phonemic Decoding Efficiency) was in the borderline range. His reading comprehension ability (WJ-III ACH Passage Comprehension) was in the borderline range. Thus, his ability to orally read real words and pseudowords accurately was considerably more developed than his ability to read real words and pseudowords quickly or to comprehend read text.

John's accuracy for orally reading single real words (WJ-III ACH Word Identification) was in the below average range, but his accuracy for orally reading pseudowords (WJ-III ACH Word Attack) was in the low average range. However, his oral reading rate for single real words (TOWRE-2 Sight Word Efficiency) or pseudowords (TOWRE-2 Phonemic Decoding Efficiency) was in the borderline range. His reading comprehension ability (WJ-III ACH Passage Comprehension) fell in the borderline range. Overall, John demonstrated a relative strength for accuracy of oral reading of

pseudowords but relative weaknesses in all the other reading skills assessed.

Writing profile

For writing the ordered letters of the alphabet from memory, Jack scored better when typing and allowed to look at the keys than when handwriting (either print or cursive). He could not write any letters in cursive. For sentence copying (model present for letter writing), he scored in the borderline range for copying in his best handwriting (DASH Copy Best) but below average range for rate (DASH Copy Fast). Jack demonstrated a relative strength in choosing the correct spelling among phonological foils (TOC Word Choice) in the low average range and a relative weakness in the other two spelling skills with performance in the borderline range—dictated spelling (WIAT-III Spelling) and word anagrams (TOC Word Scrambles—reordering letters to create correctly spelled real words). His sentence composing was in the borderline range on both WIAT-III Combining Sentences and WJ-III ACH Writing Fluency.

John performed best when producing alphabetic letters with the keyboard compared with handwriting manuscript or cursive letters. He could not write any letters in cursive. His performance on sentence copying was in the borderline range for both DASH Copy Best and Copy Fast. John scored higher (low average range) on measures requiring spelling judgments (TOC Word Choice and Word Scrambles) than dictated spelling (WIAT-III Spelling, borderline range). His sentence composing was in the below average range on both WIAT-III Combining Sentences and WJ-III ACH Writing Fluency.

Executive functions profile

Jack's executive functions were variable. Jack's scaled score fell in the below average range for selective attention (D-KEFS Color Word Form Inhibition). His abilities to rapidly name lowercase letters (average range on RAN) and switch attention (low average range on RAS) were relative strengths compared with his selective attention. Jack

demonstrated a weakness in the orthographic loop (Alphabet 15 Rapid Automatic Letter Writing z-score).

John's executive functions were also variable. He performed in the below average range on selective attention (D-KEFS Color Word Form Inhibition) and orthographic loop (Alphabet 15 Rapid Automatic Letter Writing z-score). In contrast, he performed in the average range on rapidly naming lowercase letters (RAN) and low average range on switching attention (RAS).

Comparison of Jack's and John's preintervention profiles

See Table 1 for an overview of observed intraindividual differences (i.e., comparing within the categories of skills in the columns for Jack and in the columns for John) and interindividual differences (i.e., comparing scores of Jack and John for the same measure across the rows). Both Jack and John exhibited variability within their own learning profiles (intraindividual differences) before participating in the instructional intervention. They exhibited patterns of strengths and weaknesses in cognitive, aural and oral language, reading, writing, and executive functions. Some of these strengths and weaknesses were shared in common, for example, on executive functions, but some of these were not shared in common (interindividual differences).

Research aim 2: Response to instruction based on pretest–posttest changes

To compare Jack and John on their response to computerized instruction from pretest to posttest on standardized tests with norms, see Table 1 for measures on which they met the criterion adopted for reliable response to instruction in the current study and other published research using these lessons (at least one-third standard deviation on standard scores or scaled scores). Footnote indicator "h" beside a measure in Table 1 indicates whether either Jack or John met the criterion on that measure. Posttest scores and ranges are provided in the main

text along with the pretest scores and ranges (in Table 1) for pretest–posttest changes that met the criteria used in this and prior research involving the same computerized instruction. Only raw scores and *z*-scores are available for the Alphabet Writing from Memory Task and Orthographic Loop, respectively.

Aural language, oral language, and reading. Only John showed response to computerized instruction in aural and oral language. On the CELF-4 Formulated Sentences, his scaled score changed from a 5 in the borderline range to 7 in the low average range. Neither Jack nor John showed response to computerized instruction in reading.

Alphabet writing in alphabetic order from memory. Jack showed response to computerized instruction in manuscript printing (from 3 to 24 legible letters), cursive writing (from 0 to 5 legible letters), and in keyboarding (from 19 to all 26 accurate key presses). John showed response to computerized instruction in manuscript printing (from 4 to 12 legible letters), cursive writing (from 0 to 8 legible letters), and keyboarding (from 8 to all 26 accurate key presses).

Spelling. Jack showed response to computerized instruction in dictated spelling (from 78 in the borderline range to 90 in the average range on WIAT-III Spelling), TOC Word Choice (from 7 in the low average range to 9 in the average range), and TOC Word Scrambles (from 4 in the borderline range to 7 in the low average range). John demonstrated response to computerized instruction in TOC Word Choice (from 6 in low average range to 7 in the low average range) and TOC Word Scrambles (from 6 in low average range to 8 in the average range).

Composing. Jack showed response to computerized instruction in WIAT-III Sentence Combining (from 74 in the borderline range to 95 in the average range). John showed response to computerized instruc-

tion in WIAT-III Sentence Combining (from 69 in below average range to 80 in low average range) and WJ-III ACH Writing Fluency (from 57 in below average range to 78 in borderline range).

Executive functions. Both participants showed response to computerized instruction in working memory components supporting the executive functions in language learning. Jack showed response to computerized instruction on D-KEFS Color Word Inhibition (from 1 in below average range to 6 in the low average range) and Orthographic Loop (from -2.50 z in below average range to -1.63 z in borderline range). John showed response to computerized instruction on RAS (from 85 in the low average range to 99 in the average range) and Orthographic Loop (from -2.48 z in below average range to -1.80 z in borderline range).

Summary response to instruction comparisons between participants. Both participants displayed response to computerized instruction on seven measures: subword-level Writing the Alphabet from Memory for manuscript, cursive, and keyboarding tasks; word-level TOC Word Choice and TOC Word Scrambles; and sentence-level WIAT-III Sentence Combining, as well as orthographic loop for integrating mental representations of letters with graphomotor output through the hand. John demonstrated response to computerized instruction on four additional measures: oral expression (CELF-4 Formulated Sentences), sentence copying (DASH Copy Best), sentence writing (WJ-III ACH Writing Fluency), and attention switching (RAS). Jack demonstrated response to computerized instruction on two additional measures: dictated spelling (WIAT-III) and selective attention (D-KEFS Color Word Form Inhibition). Neither participant showed response to computerized instruction on any reading skills (a possible explanation is offered in the discussion).

Research aim 3: Response to instruction for personal narratives across first six lessons

Table 2 provides the six personal narratives that Jack and John each composed. Jack produced writing during all six lessons for stylus and keyboarding conditions, but he produced more writing during the keyboarding condition (Lessons 4–6) than during the stylus condition (Lessons 1–3). For all six personal narratives, Jack wrote about topics unrelated to the task that were of interest to him, focusing on specific details or his beliefs about movie actors and video game characters. Although his texts produced for Lessons 1–5 appeared unrelated to the prompts, his text produced for Lesson 6 appeared implicitly and tangentially related to the administered prompt. The prompt for Lesson 6 asked Jack to write about his interests inside and outside of school, to which Jack wrote about Waluigi (a video game character), but he never identified this specifically as his interest. Overall, the nature of his personal narratives differed markedly from what was observed in other studies employing these tasks with typically developing writers and readers and students with dysgraphia, dyslexia, and OWL LD (Tanimoto et al., 2015). He showed no evidence of applying the taught strategies for writing the next sentence or creating text structure (Niedo et al., 2016).

John's personal essays had been coded for length and for Level 1 Strategies for the Next Sentence and Level II Strategies for Connecting Sentences (which can co-occur with Level I strategies) by the first and last authors of Niedo et al. (2016) at the time that article was in preparation. All items were discussed until the two coders were in agreement. In contrast to Jack, John wrote more by stylus than by keyboarding. Although he generally wrote about the topic of the prompt assigned, for Personal Narrative 3 he appeared to have a flashback to earlier years in his schooling (upper elementary school rather than his life after schooling was over). Of the taught strategies described in the study by Niedo

et al. (2016), John applied the following strategies (frequencies in parentheses) for each of the personal narratives across the six sessions (lessons). For Personal Narrative 1, John stated a goal (1). For Personal Narrative 2, John described and painted a picture with words (12), described observable behavior (4), described a state of mind or feeling (1), and qualified a prior statement (2). Across these Level I strategies, six co-occurred with tying other sentences together with a connecting word and/or sentence (Level II strategy). For Personal Narrative 3, John stated a wish (2), described observable behavior (2), qualified a prior statement (3), described and painted a picture in words (3), described a state of mind or feeling (2), and stated a goal or plan (1). Across these Level I strategies, one co-occurred with making a comment that interrupts the ideas in progress and continues with that idea and three co-occurred for tying other sentences together with a connecting word and/or sentence (Level II strategies). For Personal Narrative 4, John described and painted a picture in words (6), and each time co-occurred with tying the other sentences together with a connecting word and/or sentence (Level II strategy). For Personal Narrative 5, John described and painted a picture in words (3), qualified a prior sentence (2), and described a state of mind or feeling (1). For Personal Narrative 6, John illustrated using one or more examples or counterexamples (2) and provided an explanation (1).

Length (number of sentences) and coherence (relevance of each sentence to the topic of the personal narrative) were computed for each personal narrative a participant wrote. For Personal Narrative 1, Jack wrote one sentence that was not on topic, whereas John wrote two sentences with one on topic. For Personal Narrative 2, Jack wrote one sentence that was not on topic, whereas John wrote 18 sentences with four on topic. For Personal Narrative 3, Jack wrote one sentence that was not on topic, whereas John wrote 13 sentences with one on topic. For Personal Narrative 4, Jack wrote seven sentences that

were not on topic, whereas John wrote six sentences with all six on topic. For Personal Narrative 5, Jack wrote 19 sentences that were not on topic, whereas John wrote six sentences with all six on topic. For Personal Narrative 6, Jack wrote 32 sentences that were not on topic, whereas John wrote three sentences with three on topic.

Response to computerized instruction for personal narratives

Jack showed increased sentence production from Lessons 1 and 2 to Lessons 5 and 6, possibly because of response to computerized instruction for transcription skills and/or use of keyboarding for the last three narratives, but not in writing on-topic, possibly because of his ongoing difficulties in translation (i.e., he never showed evidence of applying the taught strategies for composing—translating ideas into written language) and ADHD. John showed response to computerized instruction in translation (i.e., 100% sentences on topic in last three personal narratives compared with far fewer on topic in the first three personal narratives). He also showed evidence of response to computerized instruction in translation based on use of the taught strategies for composing before writing the personal narratives. See Table 2 for the medium (stylus or keyboard) used to compose each personal narrative. The coders did not have difficulty deciphering the letters produced by stylus in these personal narratives.

Behavioral observations during computerized instruction

Jack was cooperative and completed assessments and lessons without exhibiting any behavioral difficulties, even though he rarely interacted with anyone else in the room—adults who were teachers monitoring participants' attention to and engagement in the various computer-learning activities or other students. When keyboarding, although familiar with the medium, Jack (like all participants) used hunting and pecking (rather than touch-typing without looking at the keys). In addition, Jack (like many other par-

ticipants) often did not use the fully allotted time to complete learning activities such as composing in contrast to the self-paced ones with the computer program transitioning to another learning activity immediately upon completion of that learning activity.

John, in contrast, although initially shy, became very sociable and personable and interacted with both the adults and the other students in the room when the computerized instruction took place. He responded cheerfully and cooperatively when reminded to focus on a task at hand. He did not distract the other students when they were working but appeared to enjoy talking to them during arrival and set up and at dismissal when parents arrived for their children and laptops were put away.

DISCUSSION

First, the results are discussed in reference to each of the research aims. Next, the limitations of this exploratory case study comparison of two contrasting disabilities are considered. Finally, the potential contributions from the current study are considered along with proposals for future research directions based on the findings of the current study.

Research aim 1: Comparing ASD with OWL LD on learning profiles

As summarized in the Results section, when assessment is based on cognition (social, verbal, and nonverbal), aural and oral language, reading, writing, and executive functions for language learning, the learning profiles for ASD and OWL LD share common and unique relative strengths and weaknesses. Past research has documented the challenges that individuals with ASD have in oral language and reading (e.g., Randi, Newman, & Grigorenko, 2010), but the current research supported heterogenous strengths and weaknesses when an overall learning profile was obtained (e.g., Bauminger-Zviely, 2014; Mayes & Calhoun, 2008). Moreover, the learning profile allowed for the assessment of not only writing skills but also associated skills that

affect writing development. This is a noted contribution as few past empirical studies have included skills other than cognitive abilities when assessing writing abilities (i.e., Brown et al., 2014; Dockrell et al., 2014; Zajic et al., 2018). Also, the focus on writing abilities is needed when past research has often assessed only other academic abilities such as reading and mathematics (e.g., Jones et al., 2009).

In addition, assessing the same overall learning profile allowed for a comparison of common and unique strengths and weaknesses within an individual (intraindividual differences) and between individuals (interindividual differences) with contrasting disabilities. Both children demonstrated language difficulties, but these contrasted in some ways, which were described in reference to findings of Specific Aim 2, especially for literacy (reading and writing). For example, both children demonstrated significantly impaired social cognition via assessment but demonstrated contrasting social behaviors. While Jack rarely interacted with others and was receiving special education services at school for social skills difficulties, John demonstrated shy behaviors but interacted with the adults and other children in socially appropriate ways. Exclusive use of group comparisons of multiple individuals with a specific disability does not enable comparisons at the individual level. Individuals with specific disabilities may exhibit hallmark deficits associated with a particular diagnosis but also exhibit their own variations in patterns of strengths and weaknesses over and beyond the hallmark patterns.

Research aim 2: Response to computerized instruction for ASD and OWL LD

As reported in the results for assessment measures on which students met criteria for response to computerized instruction, both children showed similar responses on some measures but differed on others. Overall, both showed response to computerized instruction on multiple levels of language for writing ranging from subword letter production to word-level spelling to sentence-level composing. Interestingly, both Jack and John improved in handwriting/letter production (for manuscript, cursive, and keyboarding) from pretest to posttest following the computerized handwriting instruction. As with other students with SLDs (dysgraphia, dyslexia, and OWL LD; Tanimoto et al., 2015), John showed response to computerized instruction on two hallmark measures that contributed to his diagnosis—oral sentence formulation and written sentence construction (composing). Of the two sentence-composing measures in Table 1 (WIAT-III Sentence Combining and WJ-III ACH Writing Fluency), Jack showed response to computerized instruction on one, and John showed it on both (see footnote indicator "h" in Table 1). Unlike the study by Tanimoto et al. (2015), neither of the boys demonstrated response to computerized instruction for any of the reading measures. One possible reason for this finding is that the computerized intervention emphasized silent reading skills needed in the upper grades when most reading is silent, but the pretest and posttest measures used oral reading tests or a test that required an oral response. Both boys improved on at least two executive functions for language learning following the computerized instruction developed for this purpose.

Research aim 3: Response to computerized instruction for personal narratives

Although Jack produced more words while keyboarding, his personal narrative composing did not show response to computerized instruction across the six sessions and was markedly poorer than what was observed in the Tanimoto et al. (2015) and Niedo et al. (2016) studies of response to computerized instruction with the same computerized instruction for personal narratives. These findings do align with past research on ASD showing preference for or better productivity when using keyboarding compared with handwriting for some children with ASD (Ashburner, Ziviani, & Pennington,

2012; Schneider, Codding, & Tryon, 2013). Jack also showed consistent translation difficulties by producing predominantly off-topic writing. John produced more text while writing with a stylus and produced some on-topic writing for the demands of the particular personal narrative prompts. Also, John applied some of the taught strategies for composing but Jack never did. Although limited to these case comparisons, these findings support distinct differences in translation processes between these children with ASD and OWL LD.

Different theories provide insight into the off-topic writing of both ASD and OWL LD. From a social communication perspective, Jack may have experienced difficulties interpreting what he needed to do for writing for an audience on a particular task and defaulted to producing text that he wanted to produce that was of interest to him. Challenges with social communication have been shown to be predictive of translation abilities but not transcription quality in children with ASD (Dockrell et al., 2014). From an executive function perspective, Jack may have experienced difficulties in self-regulating his behaviors for the task or adopted self-directed goals rather than task-specific goals. Perhaps self-management instruction would help Jack stay on topic and be mindful of his audience more so than the prompting used in this intervention (e.g., Asaro-Saddler, 2016). From a motivational perspective, Jack may have preferred writing about his own interests compared with topics offered by the computer. But, is it possible thinking about his own autobiography triggered text production about the various video games he enjoys playing? For example, Jack's last personal narrative writing sample focused on Waluigi, a video game character of interest to Jack, but he did not make the reason for writing about Waluigi explicit to the audience. Although Jack did not show response to computerized instruction on his personal narratives, he did on one of the standardized, normed measures of composing (see WIAT-III Sentence Combining in Table 1). Whereas composing personal narratives requires self-generation of thoughts and translating them into written language, sentence combining provides support for the initial generation of ideas and requires only that the writer combine them to express those ideas in one complete sentence. Thus, independent translation may pose special challenges for those with ASD. Also, challenges with on-topic production in narrative generation may be due not only to social communication challenges (e.g., Losh & Capps, 2003) but also to bias for detail-focused processing rather than global processing (e.g., Happé & Frith, 2006). It appeared that Jack fixated on topics relevant to him once he was able to write with the keyboard; thus, he demonstrated increased transcription abilities but produced writing that showed difficulties attending to the task demands.

Limitations

As is the case with in-depth case studies, one limitation of the current study is the limited sample size of one for each disability. Results for both Jack and John cannot be generalized to all individuals with ASD or OWL LD, respectively. This exploratory study offered a methodological approach for assessing overall learning profiles to identify intraindividual differences within disability groups as well as interindividual differences between disability groups. This study did not seek to answer questions about the causal mechanisms underlying the language-learning difficulties experienced by children with ASD or OWL LD, but the hypotheses and observations raised from this study offer insights for designing potential future larger scale studies. As the intervention was designed for children with SLDs, the intervention offered tentative interpretations rather than definite answers about effective instruction for children with ASD. In addition, although the current study focused on personal narratives as an informative initial comparison between ASD and OWL LD, further research is needed to understand the challenges both groups of children may experience with learning to integrate multiple levels of language in writing for different types of writing tasks both at this transition point to secondary education and across the earlier elementary grades.

Future research directions and contributions of the current research findings

Educational applications

Simply using an evidence-based intervention designed for individuals with SLD may not help a student like Jack with ASD without further adaptations aligned with the specific learning profile. For example, although Jack showed response to computerized instruction for two executive functions assessed with normed measures, he did not appear to apply executive functions to manage meeting task demands in his personal narrative composing. Effectiveness of additional supports beyond those needed for SLD (Price et al., 2017) like those offered by Fleury et al. (2014), Asaro-Saddler (2015), or Pennington and Delano (2012) for supporting writing (e.g., priming, peer support, video modeling, explicit strategy instruction, self-management instruction, and graphic organizers) should be investigated in future ASD research with attention to intraindividual as well as interindividual differences. Further research is needed on the effectiveness of alternative approaches to intervening with specific handwriting and composing difficulties experienced by children with ASD. Different types of assistive technologies have been used for children who demonstrate ongoing difficulties with writing (e.g., MacArthur, 2013), and researchers are just beginning to understand how specific assistive technologies can support the challenges children with ASD experience with handwriting, writing conventions, prewriting, and the writing process (Coffin et al., 2016). Future research should continue to draw on both what is known about the effective approaches to the multifaceted academic challenges of children with ASD (Fleury et al., 2014; Wong et al., 2015) and to the effective writing practices available for students struggling with writing (Graham & Perin, 2007) to design effective writing interventions for children with ASD (e.g., Asaro-Saddler, 2015, Pennington & Delano, 2012). Such research needs to incorporate broader perspectives about relationships between the linguistic, cognitive, and social demands of writing and difficulties presented by children with ASD (Dockrell et al., 2014; Zajic et al., 2018). The multileveled language framework presented here is but one approach to understanding these complexities for students with ASD like Jack in order to provide appropriate instruction.

Unpacking the writing challenges children with ASD can face requires multifaceted, informed approaches that seek to assess and contextualize underlying difficulties associated with writing and can be used to develop effective instructional approaches. Although research has continued to improve over the last two decades for both the identification of and the intervention for these specific writing challenges, researchers and educators still have much more to understand regarding how to support children with ASD who experience difficulties with writing. A similar case can be made for OWL LD. Not all reading problems are dyslexia, and some students with SLD such as those with OWL LD need more than phonological awareness and phonological decoding instruction, such as orthographic, morphological, and syntactic awareness learning activities (Berninger & Wolf, 2016). For example, future research should investigate how prevalent social cognition difficulties are in OWL LD, as found in the current study, and thus require teaching perspective taking in writing for varied audiences. Also, this study focused on a specific stage of development—transition to high school (ninth grade) after the summer intervention. Future research should conduct cross-sectional and longitudinal comparison studies of children with ASD and OWL LD across elementary and secondary grades.

Research design issues

Both group designs with multiple participants in well-defined groups and individual case designs with well-defined multiskill learning profiles contribute to EBPs. The group designs help identify reliable findings about EBPs that can be generalized to establish best practices for students in general, if qualified

by the need to individualize for some students. The individual case designs that compare cases that contrast on a well-defined specific variable help with translation science—the application of research findings for general categories of learners to an individual within such categories. Individuals vary within groups and between groups, and both intraindividual and interindividual differences are relevant to translation science for assessment and instruction, that is, applying knowledge from research on general principles of effective instruction to teaching a particular individual student who may share commonalities as well as variations with the research participants.

CONCLUSIONS

This study analyzed the academic learning challenges of an adolescent with ASD and an adolescent with OWL LD both before and after computerized instruction. The results were informative about the common and unique features of learning profiles and response to instruction for students with these disabilities and might inform future needed research on understanding the transcription and translation processes in larger groups of children with ASD or OWL LD. Although the profiles demonstrated cannot fully represent all children with ASD or OWL LD, the approach described here provides a comprehensive framework for understanding the individual learner and the heterogeneous learning challenges experienced by children with ASD or OWL LD. Comprehensive assessment of profiles of relevant skills helps educational practitioners design interventions individually tailored to individual students and assess their response to the interventions.

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