

Research Article

Stability of Literacy Profiles of Adolescents With Autism Spectrum Disorder and Associations With Stakeholder Perceptions of Appropriate High School Support Needs

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Purpose: For many individuals with autism spectrum disorder (ASD), postsecondary outcomes are poor. This may be due to insufficient academic supports, particularly with regard to literacy skills, during high school. More information is needed about skill profiles so that we can better differentiate support for students with varying social, communication, cognitive, and academic proficiency levels. This study was designed to (a) identify unique literacy profiles of high school students with ASD, (b) assess profile stability over time, (c) identify predictors of profile membership, and (d) analyze stakeholder reports of required school support intensity.

Method: Participants were a diverse sample of high school students with ASD, 14–21 years old ($N = 544$), their parents, and their teachers who participated in a randomized controlled trial of a comprehensive treatment model for high school students with ASD. Standardized measures were administered to assess nonverbal IQ, autism symptomatology,

language/adaptive communication, reading comprehension, academic knowledge, and parent/teacher report of school support needs intensity. Latent transition analysis was conducted to examine sample heterogeneity and to explore the stability of the profiles. Associations between profiles and reports of support intensity were examined.

Results: Four literacy profiles were identified that were stable over 2 years: Emergent Literacy/Comprehensive Support, Low Literacy/Intensive Support, Average Literacy/Moderate Support, and Average Literacy/Limited Support. Parent and teacher reports of school support intensity generally aligned with the profiles.

Conclusions: These analyses provide insight into the diverse literacy and support needs in ASD. Implications for practice and the role of speech-language pathologists in assessment and intervention are discussed.

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Autism spectrum disorder (ASD) is currently defined as a neurodevelopmental disorder characterized by restricted interests, repetitive behaviors, and impairments in social communication (American Psychiatric Association [APA], 2013). For young adults with ASD, postsecondary outcomes are poor relative to those in the general population and those with other disabilities (e.g., Taylor &

Seltzer, 2011). Young adults with ASD and co-occurring intellectual disability (ID) are substantially less likely than those without ID to attend postsecondary education or obtain competitive employment, and while some young adults with ASD without ID in prior studies were able to obtain competitive employment or admittance to postsecondary programs, many were unable to maintain these activities (Taylor et al., 2015). These findings raise concerns that young adults with ASD are underachieving after high school, and previous research has identified several factors underlying this issue. Academic achievement has been positively associated with postsecondary education and employment outcomes for youth with ASD without ID (VanBergeijk et al., 2008). For those who pursue college programs after high school, better outcomes have also been observed for students with

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proficient communication skills (Roux et al., 2015). More information is needed about relevant skill profiles and their stability over time so that we can better differentiate support for students with varying social, communication, cognitive, and academic proficiency levels. The purpose of this article is to identify unique literacy profiles of high school students with ASD and their stability over time, as well as to examine predictors of profile membership and associations with stakeholder reports of required support intensity for school participation and learning activities.

Literacy Skills and Academic Attainment in Adolescence

In high school, there are increasing academic challenges as teachers assume students have acquired basic reading and writing skills and coursework aligned with the Common Core State Standards (CCSS, 2010) requires higher level synthesis. Literacy skills underpin academic success across content areas in secondary education settings. Currently, the CCSS emphasizes teaching the skills necessary for critical thinking and the ability to understand and utilize texts. Literate individuals must be able to engage with literary works and content area texts as well as apply reasoning and evidence collection skills in educational, vocational, and independent living contexts. The CCSS also specifies communication skills that facilitate discussion, collaboration, and presentations in educational contexts as well as oral language skills such as vocabulary, grammar, and figurative language. Taken together, proficient written and spoken language skills are integral to success in multiple contexts.

Literacy Challenges for Students With ASD

Data from the National Longitudinal Transition Study-2 indicated that adolescents with ASD were not adequately responding to the provided literacy-focused academic instruction, with mean standard scores on measures of reading comprehension approximately 2 *SDs* below average (Wagner et al., 2006). In samples that span the school-age years, reading comprehension impairments have been reported in 33%–65% of students with ASD (Davidson & Ellis Weismer, 2014; Jones et al., 2009; McIntyre, Solari, Gonzales, et al., 2017; Nation et al., 2006). Moreover, research that included more children with co-occurring ID indicated higher rates of impairment (Henderson et al., 2014; Nally et al., 2018). To understand the underpinnings of literacy challenges for students with ASD, general reading comprehension subskills, as well as ASD-specific challenges, should be considered.

Reading Comprehension for Students With ASD

The Simple View of Reading is a model that depicts successful reading comprehension as the product of word decoding (reading words quickly and accurately) and linguistic comprehension skills (Gough & Tunmer, 1986). These two broad component skills are posited to be multiplicative, and substantial deficits in either or both components will

severely constrain comprehension. An established body of research has demonstrated that receptive and expressive oral language skills underpin word decoding and linguistic comprehension in students with typical development (e.g., Cain & Oakhill, 2008). For example, phonological processing and vocabulary development have been linked with word decoding skills (e.g., Nation, 2009; Swanson et al., 2003), and vocabulary, morphology, syntax, and grammar skills support linguistic comprehension (e.g., Cain & Oakhill, 2006; Ouellette & Beers, 2010). Additionally, the ability to link between different pieces of information and integrate this with knowledge in long-term memory allows a listener or reader to make inferences that fill in gaps and resolve ambiguities about what they are reading or hearing to build deeper comprehension (e.g., Cain & Oakhill, 2008). While there is heterogeneity among individuals with ASD in word decoding and linguistic comprehension skills, researchers have linked reading comprehension difficulties for many students with ASD to cognitive impairments and language and communication deficits associated with ASD symptomatology (Brown et al., 2013; McIntyre, Solari, Gonzales, et al., 2017; Ricketts et al., 2013). We will briefly discuss associations between these factors and reading comprehension for individuals with ASD in order to inform the creation and analysis of the adolescent literacy profiles in this study.

Cognitive Skills

General levels of cognitive functioning are important to consider as both verbal and nonverbal cognitive skills typically explain substantial variance in academic achievement outcomes. Wide variability in cognitive skills of individuals with ASD leads to the need to examine their association with heterogeneity in literacy skills in order to gain insight into the specific strengths and challenges of different learners. Current prevalence rates indicate that 30% of students with ASD have a co-occurring ID (Maenner et al., 2020). For these students, reading skills are substantially lower, and research on students with severe disabilities indicates that most students with significant ID are emergent readers (Erickson et al., 2010). Emergent readers' understanding and use of print is focused on the reading and writing behaviors that precede conventional reading and writing. These students are still learning the functions of print and early prereading skills, such as phonological awareness, alphabet knowledge, and foundational receptive and expressive language skills. An emergent literacy level places a student in secondary education well behind same-age peers.

Language Skills

Oral language skills often develop atypically in children with ASD, with concerns about language delays frequently prompting the initial referral for evaluation (e.g., Eigsti et al., 2011). They display wide variability in development of their expressive and receptive language abilities, and extant research has reported language subgroups in children with ASD (e.g., Rapin et al., 2009; Tager-Flusberg & Joseph, 2003). Tager-Flusberg and Joseph (2003) identified

two language subtypes among verbal children with autism: children with relatively normal linguistic abilities and those with impairments. Children with more normal linguistic abilities demonstrated intact phonological skills, fluency, syntax, morphology, and average-to-large vocabularies, but many displayed poorer comprehension above the word and sentence level. Children with impaired language had phonological processing deficits and scores 1–2 *SDs* below the mean on most structural language tests, struggling particularly with higher order syntax and semantics. Challenges with these skills underlie both word decoding and reading comprehension impairments for students with ASD (e.g., Brown et al., 2013; Lindgren et al., 2009; Lucas & Norbury, 2014). Furthermore, impairments in higher order linguistic comprehension skills, such as narrative and inference abilities, are linked with the oral language skills that are particularly challenging for many readers with ASD (McIntyre, Solari, Gonzales, et al., 2017; Ricketts et al., 2013). Thus, the link between receptive and expressive language skills and reading is important to consider when identifying literacy profiles.

ASD Symptomatology

The primary diagnostic characteristics of ASD, social communication impairments, and repetitive and restrictive behaviour (APA, 2013) have been shown to impact reading comprehension. Much of human learning is intrinsically social as we learn with and from others (Mundy et al., 2012; Tomasello, 2010). Social communication, or the ability to use language and nonverbal communication in a purposeful way to convey a message to another person, plays a role in understanding that written texts are a form of communication with an intended purpose. Not only must one interpret an author's or speaker's intent, but when reading or listening to narratives, the ability to attribute mental states such as desires and motivations to characters plays a crucial role in understanding and predicting their behaviors. Beyond these skills, restricted interests often result in an extensive focus on, and depth of knowledge of, one or two topic areas that divert attention from broader learning experiences. This narrow range of interests can limit the breadth of background knowledge in long-term memory that is available for inference making with narrative and content area expository texts. Therefore, it is important to consider the extent and focus of students' preferred interests and to assess the breadth and depth of their background knowledge across core content areas. Taken together, evidence indicates that reading comprehension challenges may also align with ASD-specific vulnerabilities (e.g., Brown et al., 2013; Erickson et al., 2010; McIntyre, Solari, Gonzales, et al., 2017; Ricketts et al., 2013); therefore, autism symptomatology, as well as general content area background knowledge, should be considered when identifying literacy profiles in adolescents with ASD.

Parsing Heterogeneity: Identifying Subgroups

Since ASD is, by definition, a developmental disorder characterized by a continuum of impairment, there is extensive

heterogeneity among individuals with ASD. Researchers have emphasized the need to describe more homogenous subgroups among individuals affected by ASD to clarify the etiology, course, treatment, and outcomes for these individuals (Georgiades et al., 2013; Stevens et al., 2000). Prior longitudinal research with children and adolescents with ASD has reported a range of two to seven subtypes across ASD symptomatology, cognitive, language, sensory, and adaptive behavior skills (Ausderau et al., 2016; Baghdadli et al., 2018; Pickles et al. 2014; Solomon et al., 2018; Stevens et al., 2000; Szatmari et al., 2015; Tomaszewski et al., 2019).

Use of these methodologies allows researchers to maximize homogeneity in well-characterized subsamples to increase statistical power and allow subgroup-specific hypotheses first to be tested within selected subgroups and later to determine generalizability to new samples or contexts (Ousley & Cermak, 2014). Also, the identification of subgroups in educational contexts allows for more precise alignment of instruction, intervention, and educational plans (Beglinger & Smith, 2005). Research findings are emerging that address distinct learner profiles that would advance educational practices specifically for students with ASD.

Heterogeneity in academic achievement has been reported in two studies that probed for subgroups in school-age children with ASD. In the only study to solely examine adolescent academic profiles, Jones et al. (2009) identified four distinct reading and math profiles in students with ASD at one time point. They found that, relative to full-scale IQ, the most pervasive profile was discrepantly poor reading comprehension. In the first study of longitudinal growth patterns of academic profiles, Wei et al. (2015) reported four distinct reading and math achievement profiles in 6- to 9-year-old students with ASD: higher achieving (average reading and math), hyperlexia (average word decoding alongside poor reading comprehension), hypercalculia (average math calculation skills alongside poor applied math problem solving skills), and lower achieving (poor reading and math). Longitudinal findings were varied for reading and math skills within and between profiles, but notably, all four profiles demonstrated declining reading comprehension scores relative to norming samples over time.

Two studies examined subgroups of readers within samples of students with ASD. Davidson and Ellis Weismer (2014) investigated early reading profiles in 4- to 6-year-olds with broad variability in nonverbal IQ scores, and McIntyre, Solari, Grimm, et al. (2017) investigated reading profiles in 8- to 16-year-old students with ASD without ID. Both studies reported a subgroup with average reading ability that did not show deficits in decoding or comprehension. McIntyre et al. found that this subgroup had the mildest ASD symptomatology and highest oral language scores of their four reported subgroups. They also reported a mixed-deficit profile marked by global impairments in all reading and language measures that was associated with significantly higher ASD symptomatology.

A third study followed up on the McIntyre, Solari, Grimm, et al. (2017) sample and examined the stability of the reading profiles (composed of phonological processing,

decoding, oral language, and comprehension variables) over 30 months using latent transition analysis (Solari et al., 2019). The four groups were relatively stable, but students who moved groups demonstrated mixed progress over time. Eleven percent of students in the average profile and 15% in the poor comprehension profile performed more poorly at follow-up. However, growth was demonstrated by about a quarter of the students in the discrepantly poor comprehension, mild mixed-deficit, and more severe mixed-deficit profiles 30 months later. To date, no study has examined the stability of literacy profiles in a sample of adolescents with ASD across a wide range of cognitive abilities.

School Support Needs

To be eligible for services under the category of autism as delineated in the Individuals with Disabilities Education Act, a student must meet a state's diagnostic criteria for ASD, and the educational team must also conclude that autism symptoms interfere with learning and the student needs special services to make academic progress. Students demonstrating different literacy profiles likely require supports that vary in intensity. Support needs can be conceptualized as the type and intensity of support a person requires to participate in culturally valued, age-appropriate settings and activities (Shogren, Shaw, et al., 2017). Assessing stakeholders' perceptions of support needs required to facilitate school participation and learning activities can inform our understanding of subgroups. For example, the current diagnosis of ASD (APA, 2013) includes a classification system related to the amount of support required around social communication and restricted, repetitive behavior challenges. This classification enables clinicians to evaluate specific challenges related to the core features of ASD and indicate the type and intensity of supports needed to enhance functioning. For literacy development in students with ASD, appropriate school support intensity can reduce the gap between a student's current capacity and the demands of the environment, and it is important to know whether it is aligned with the student's unique needs.

The Current Study

Students with ASD display broad heterogeneity in the factors underpinning proficient literacy skills. In a typical high school setting, students across the range of language and cognitive functioning engage in academic instruction in both inclusive and self-contained settings. To identify areas of strength and challenge, measures of communication skills, ASD symptomatology, academic background knowledge, and reading comprehension enable one to parse some of the extensive heterogeneity present among high school students with ASD into more homogenous subgroups with similar support needs. This study was designed to probe four research questions:

1. Are there distinct literacy profiles in a diverse sample of high school students with ASD?
2. Is profile membership stable over 2 years?

3. What are the predictors of profile membership at the first time point?
4. What is the stakeholder (teacher and parent) perception of required support intensity for school participation and learning activities for each profile?

Method

Participants

Participants were drawn from a randomized controlled trial of a comprehensive intervention program for high school students with ASD. The study included 60 high schools located in central North Carolina; southeast, central, and northern Wisconsin; and southern California. The intervention program targeted four components: academics, social skills, independence, and transition. Students received various combinations of these components based on their educational goals. For detailed intervention information, see Odom et al. (2014) and Steinbrenner et al. (2020). School participation was voluntary, and approval was sought from district administrators and key personnel at each school before being included in the study. All schools were funded publicly and were not exclusively special education schools (i.e., only for students with disabilities). Schools were randomized at the district level using block randomization to receive the intervention or services as usual. High school students with ASD, their parents, and their teachers were recruited at each high school. Schools had a range of four to 12 students each, resulting in 301 students receiving the intervention and 243 receiving services as usual. There were no relevant main effects for the intervention in this study; thus, analyses have controlled for intervention group to ensure that the intervention groups did not have effects in the current analyses.

Adolescents and their parents consented to participation, and the study was conducted in compliance with the University of North Carolina at Chapel Hill Institutional Review Board. Students were eligible for participation if they (a) were receiving educational services under the special education category of autism as delineated in the Individuals with Disabilities Education Act, (b) had a minimum of 2 years remaining in their high school program, (c) were between 13 and 22 years old, and (d) did not have significant visual or hearing impairments. The individuals included in this study were 544 high school students with ASD, their parents, and their teachers. Participants were an average age of 16.2 years ($SD = 1.44$) at the time of enrollment in the study, were predominately male (86%), and represented a diverse sample (45% non-White or Hispanic) across a range of intellectual functioning and autism severity. The demographic information is in Table 1. There were no statistically significant differences between intervention and control groups.

Procedure

Trained research staff administered an assessment battery at two time points. The first time point was in the

Table 1. Demographic and descriptive characteristics at Time 1.

Variable	% or <i>M</i> (<i>SD</i>)
Race	
American Indian/Alaskan Native	2.7
Asian	4.5
Black/African American	14.0
White	67.0
Multiracial	7.3
Other	4.5
Ethnicity	
Hispanic	20.0
Non-Hispanic	80.0
Maternal education (% high school degree or less)	19.1
6th–8th	1.6
Partial high school	2.8
High school degree/high school equivalency diploma (GED)	14.7
Associate/technical degree or some college	32.9
Bachelor's degree	31.5
Masters/doctoral degrees	16.4
Family income	
< \$20,000	8.1
\$20,000–\$39,999	15.7
\$40,000–\$59,999	14.1
\$60,000–\$79,999	14.3
\$80,000–\$99,999	12.6
> \$99,999	35.2
Diploma track (% standard)	56.4
Nonverbal IQ	85.5 (27.2)
< 70	26.4
≥ 70	73.6
Range	30–141
Social Communication Questionnaire Lifetime	20.8 (7.6)
Autism (% meeting cutoff of > 15)	80
Range	0–37

fall of the school's first year of participation ($N = 544$). The second time point was conducted at the end of the second year ($N = 483$). The assessment battery included direct assessments and questionnaires completed by the students and questionnaires completed by parents or caregivers and teachers. Teachers included case managers, classroom teachers, or autism support teachers with knowledge of the student with ASD. Teachers could complete questionnaires on multiple students if applicable.

Measures

Demographics and Student Information

Parents or caregivers provided demographic information regarding student age, race, and ethnicity. Teachers provided information regarding the school diploma track, indicating whether the student was in a standard diploma track or on a modified diploma track. Students in the standard diploma track completed courses that met requirements for high school graduation and entry into a community college or college. Students in the modified diploma tracks did not meet requirements for a high school diploma that allows entry into college settings but could receive a certificate of completion.

Nonverbal IQ

Nonverbal IQ was measured using the Leiter International Performance Scale–Third Edition (Roid et al., 2013). The Leiter International Performance Scale–Third Edition is a standardized cognitive assessment for individuals ages 3–75+ years. The nonverbal IQ comprises four subtests that measure intellectual ability across visualization (Figure Ground and Form Completion) and fluid reasoning (Classification/Analogies and Sequential Order). The nonverbal IQ is calculated from sums of the four subtest scaled scores. These scores are converted to a normalized IQ standard score ($M = 100$, $SD = 15$). Internal consistency reported in the normative sample was acceptable to high across subtests for ages 13–29 years (Cronbach's $\alpha = .67-.95$).

Academic Achievement

Academic achievement was measured using the Woodcock–Johnson III Tests of Achievement (Woodcock et al., 2001). It is a standardized measure of academic achievement composed of subtests assessing reading, oral language, mathematics, written language, and academic knowledge. Participants in this study completed two subtests: Passage Comprehension and Academic Knowledge. Passage Comprehension assesses broad reading and reading comprehension skills. Academic Knowledge assesses students' background knowledge in three subtests: Science, Social Studies, and Humanities. All subtests require nonverbal and oral responses. Raw scores are converted to normative scores for each subscale. In this study, standard scores were used for each subscale ($M = 100$, $SD = 15$; Mather & Woodcock, 2001). Internal consistency reported in the normative sample was high across subtests (Cronbach's $\alpha = .80-.90$).

Communication Adaptive Behavior

Teachers completed the Vineland Adaptive Behavior Scales–Second Edition Teacher Rating Form (Sparrow et al., 2006). It is a standardized assessment of adaptive behavior in a school-based setting for students from ages 3 to 21 years that assesses adaptive behavior across Communication, Daily Living Skills, and Socialization for students ages 7–21 years. The Vineland Adaptive Behavior Scales–Second Edition demonstrated high internal consistency in the current study (Cronbach's $\alpha = .99$). In this study, the subdomains of the Communication domain were used in analyses in order to observe the separate contributions of receptive, expressive, and written language to literacy profiles. The receptive subdomain assesses how well a student understands language, listens, and pays attention. The expressive domain assesses the extent to which a student uses words and sentences to retrieve and provide information. The written subdomain assesses the students reading and writing abilities. The v -scale scores were used in this study ($M = 15$, $SD = 3$). The v -scale score ranges are classified as follows: < 9 as low, 10–12 as moderately low, 13–17 as

adequate, 18–20 as moderately high, and 21 or above as high.

Autism Symptom Severity

The Social Communication Questionnaire and the Social Responsiveness Scale–Second Edition demonstrate good agreement across studies (Bolte et al., 2008; Charman et al., 2007). Teachers completed the Social Responsiveness Scale–Second Edition (Constantino & Gruber, 2012). It is a standardized assessment of autism symptoms. Teachers completed the School-Age Form that includes 65 items for students ages 4–18 years. The total *T* score ($M = 50$, $SD = 10$) used in this study is the standard score that indicates social communication difficulties in comparison to the nationally representative standardization sample. *T* scores of 59 and below are classified as within normal limits and are not clinically significant. *T* scores of 60–65 are classified as mild and considered clinically significant and indicative of social behavior difficulties interfering mild to moderately with everyday social interactions. *T* scores of 66–75 are classified as moderate and indicative of social behavior difficulties that interfere substantially with everyday social interactions. *T* scores of 76 or higher are classified as severe and indicative of social behavior difficulties that interfere severely with everyday social interactions. This assessment demonstrated high internal consistency (Cronbach's $\alpha = .96$). Parents completed the Social Communication Questionnaire (Rutter et al., 2003). It is a 40-item measure of autism symptoms. The Lifetime Form asks parents yes/no responses across the individual's entire developmental history. The Social Communication Questionnaire demonstrated high internal consistency in this study (Cronbach's $\alpha = .87$).

Support Needs

Parents and teachers both completed the Estimates of Support Needs section of the Supports Intensity Scale–Children's Version (Thompson et al., 2012/2016). It is a measure of the intensity of support needs across contexts for students with intellectual disabilities and developmental disabilities. The Supports Intensity Scale–Children's Version has been used in children with autism and ID (Shogren, Shaw, et al., 2017; Shogren, Wehmeyer, et al., 2017; Thompson et al., 2012/2016). Respondents rate the level of support needed from *no extra support needed* (1) to *total support needed* (5). The two school items were used in this study: school participation and school learning. School participation activities are related to school community participation, and school learning includes activities involved with acquiring skills and knowledge at school, such as accessing curriculum content, and core academic subjects, such as reading. The raw score for each of these items was used as there are no standard scores available for these two items. This assessment demonstrated high internal consistency in teachers (Cronbach's $\alpha = .93$) and parents (Cronbach's $\alpha = .90$) in the current study.

Data Analysis Plan

Multilevel latent profile analysis was used to identify distinct subgroups of literacy profiles for the high school students with ASD in this study. Multilevel latent profile analysis is a person-centered approach that identifies underlying homogeneous subgroups across a set of observed continuous variables within a sample (Collins & Lanza, 2009). Traditional latent profile analyses assume observations are independent of each other; therefore, the multilevel approach was used to account for the nesting of students within schools (Asparouhov & Muthén, 2008; Bliese et al., 2018). Separate multilevel latent profile analyses were performed for the first and second time points using measures of teacher-reported autism symptom severity, receptive, expressive, and written language adaptive behavior skills and direct assessment of academic knowledge and passage comprehension.

Missing data are defined as unobserved variables that are meaningful to analyses (Little & Rubin, 2020). In the current study, 11% of participants were missing observations at the second time point. There were significant differences between intervention and control groups on those missing data. All models assumed that the missing data were missing completely at random or missing at random. Missing completely at random assumes that the cause of the missing data does not depend on any distinct variables, observed or unobserved. Missing at random is a less restrictive assumption that assumes missingness is dependent on observed variables in the data set (Little & Rubin, 2020). Deleting individuals with missing observations introduces potential bias and loss of precision in parameter estimates and standard errors and is not recommended (Enders, 2010; Graham, 2009; Little & Rubin, 2020). Therefore, missing data were estimated using full information maximum likelihood (FIML), which uses data from all participants who contributed at least one data point (Enders, 2010). FIML handles the missing data by using available data information from all participants and integrating probabilities of observed, measured variables over the incomplete data (Enders, 2010). FIML is the default method in MPlus and is recommended for longitudinal analysis due to reducing bias and increasing power (Enders, 2012).

Class enumeration, or deciding on the number of distinct classes, was determined through performing model estimations from fitting a one-class to a five-class model and using several indicators of model fit (Masyn, 2013; Nylund, 2007). The Akaike's information criterion, the Bayes' information criterion, and the sample size–adjusted Bayes' information criterion were examined as measures using information criteria, with lower values indicating better fit (Nylund et al., 2007). The different number of classes were compared using the Lo–Mendell–Rubin test to determine if adding one additional class significantly improved model fit (Lo et al., 2001). Finally, entropy was examined to determine the separation of classes. Values range between 0 and 1, where values close to 1 indicate clear class distinction (Celeux & Soromenho, 1996).

Following the determination of the distinct number of profiles for each time point, longitudinal tests of profile

similarity and latent transition analyses were tested to determine the stability of the profiles (Morin & Litalien, 2017). A sequence of profile similarity tests was conducted to determine configural similarity (same number of profiles based on same indicators at the two time points), structural similarity (same means within profiles), dispersion similarity (same within-profile variances), or distributional similarity (same probabilities or size of profiles; Ciarrochi et al., 2017; Morin & Litalien, 2017; Morin et al., 2016). The final most similar models were used in latent transition analysis to investigate longitudinal profile transitions and transition probabilities using the three-step auxiliary approach to avoid shifts in latent profiles (see Asparouhov & Muthén, 2014; Nylund-Gibson et al., 2014; Vermunt, 2010).

Predictors of profile membership were added to include group (intervention and services as usual control), IQ, diploma track, age, race/ethnicity, biological sex, and maternal education as covariates. The intervention group was also included as a predictor of transition probabilities to probe whether the intervention impacted movement between profiles over 2 years. Figure 1 presents the conceptual diagram of the latent transition analysis. Support intensity needs, as reported by parents and teachers, were analyzed as outcomes and were freely estimated across time points and profiles. The three-step approach was used to ensure that the profile definition remained unchanged at both time points using the exact parameter estimates obtained from the most similar model (see Asparouhov & Muthén, 2014; Morin et al., 2016; Nylund-Gibson et al., 2014; Vermunt, 2010).

Analyses were run using the complete sample. While 20% of the sample scored below cutoff on the Social Communication Questionnaire, supplemental analyses run with these participants excluded indicated no substantive changes in the resulting findings. Furthermore, all participants had an educational classification of autism, and teacher report on the Social Responsiveness Scale indicated all participants demonstrated substantial ASD traits.

Results

Distinct Literacy Profiles

First Time Point

The multilevel latent profile fit indices supported a five-profile model (see Table 2 for model fit statistics). However, upon examination of the profiles, two profiles had overlap across all the indicators, with no qualitative differences. Therefore, the four-profile model, which was a better fit than the three- or two-profile models, was selected due to theoretically aligning with distinct literacy profiles. The first profile was labeled Emergent Literacy/Comprehensive Support and included 20.4% of the sample. Students in Emergent Literacy/Comprehensive Support had severe autism severity, very low to moderately delayed IQs, low communication adaptive behavior scores, and very low academic achievement scores (see Table 3). The second profile was labeled

Low Literacy/Intensive Support and comprised 27.2% of the sample. Students in Low Literacy/Intensive Support had moderate autism severity, low IQs, moderately low communication adaptive behavior scores, and low academic achievement scores. The third profile was labeled Average Literacy/Moderate Support and included 26.8% of the sample. Students in Average Literacy/Moderate Support had moderate autism severity, average IQs, moderately low communication adaptive behavior scores, and average academic achievement scores. The fourth and final profile was labeled Average Literacy/Limited Support and comprised 25.6% of the sample. Students in Average Literacy/Limited Support had mild autism severity, average IQs, adequate communication adaptive behavior scores, and low average academic achievement scores. Figure 2 depicts the literacy profiles using *z* scores as the measures are not on the same scale.

Second Time Point

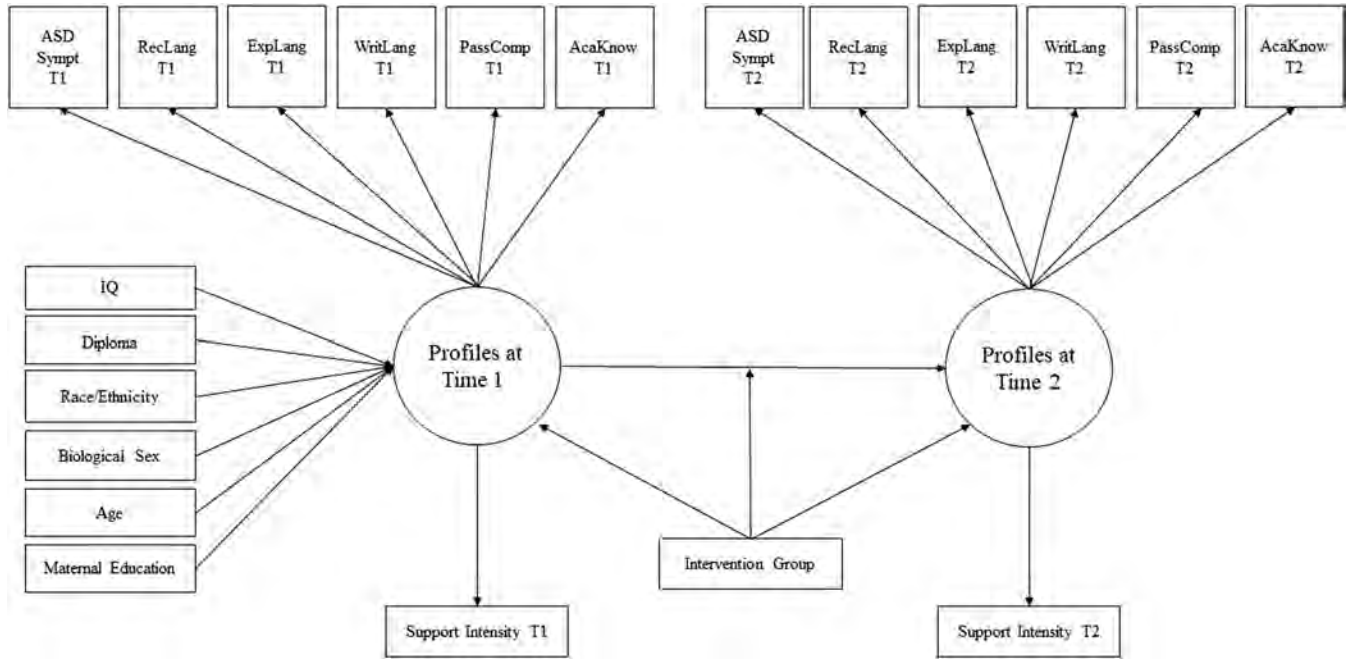
The fit statistics supported a four-profile or five-profile solution (see Table 2). The five-profile solution was not a significantly better fit than the four-profile solution according to the likelihood ratio test (LRT) and had two profiles that overlapped across indicators. Therefore, the four-profile solution was selected for the second time point. The four profiles at Time 2 were similar to those of Time 1 and represented the same profile patterns (see Table 3). The Average Literacy/Limited Support profile made up 20.2% of the sample. The Average Literacy/Moderate Support profile made up 33.2% of the sample. The Low Literacy/Intensive Support profile comprised 26.2% of the sample, and the Emergent Literacy/Comprehensive Support profile made up 20.2% of the sample. Figure 3 depicts the literacy profiles using *z* scores at the second time point.

Profile Stability: Transition Probabilities

As noted, a latent transition analysis was performed to examine the transition probabilities across time points. Overall, profile membership remained stable with 90.4% of participants remaining in their same profile (see Table 4 for transition probabilities). The most stable profile was Emergent Literacy/Comprehensive Support with only one individual transitioning to Low Literacy/Intensive Support. Low Literacy/Intensive Support was the next most stable, with 98% remaining in the profile and 2% transitioning to the Average Literacy/Limited Support. Average Literacy/Moderate Support was the next most stable, with 91% remaining in the profile and 9% transitioning to the Average Literacy/Limited Support. Average Literacy/Limited Support was the least stable, with 77% remaining in the profile, 20% transitioning to the Average Literacy/Moderate Support, and 3% transitioning to the Low Literacy/Intensive Support.

Intervention grouping had a significant effect on transition probabilities for the Low Literacy/Intensive Support profile, with five individuals from the services as usual group

Figure 1. Conceptual model of latent transition analysis. ASDSympt = Social Responsiveness Scale–Second Edition *T* score; RecLang = Vineland Adaptive Behavior Scales–Second Edition Teacher Report Form Receptive *v*-scale score; ExpLang = Vineland Adaptive Behavior Scales–Second Edition Teacher Report Form Expressive *v*-scale score; WritLang = Vineland Adaptive Behavior Scales–Second Edition Teacher Report Form Written *v*-scale score; PassComp = Woodcock–Johnson III Tests of Achievement Passage Comprehension standard score; AcaKnow = Woodcock–Johnson III Tests of Achievement Academic Knowledge standard score; Support Intensity = Supports Intensity Scale–Children’s Version; T1 = Time 1; T2 = Time 2.



transitioning to the Average Literacy/Limited Support profile at Time 2. This represents only 2% of the sample, so it is an extremely small number of participants. There could be a number of reasons that these participants transitioned. Four out of five of these students were in modified diploma tracks and started the project in 11th grade. These students

made gains on their standardized academic assessments at the second time point, which could indicate that they made academic gains in school, but also could be due to measurement error. In addition, on the teacher-reported measures, teachers reported this group had significantly improved in their autism symptomology. This could be representative of change in autism symptoms but could also be that the teacher who was rating them at the second time point was not the same teacher at the first time point. This small group of students represents the significant need for continued and reliable assessment to ensure that the right supports and programs are provided.

Table 2. Multilevel latent profile fit indices.

No. of classes	Fit statistics				
	AIC	BIC	SSABIC	Entropy	LMR (<i>p</i>)
Time 1					
1	15,375.77	15,427.34	15,389.24	—	—
2	13,892.98	13,974.62	13,914.31	.91	< .001
3	13,330.54	13,442.27	13,359.73	.88	.01
4	13,085.78	13,227.59	13,122.83	.87	.43
5	12,917.02	13,088.90	12,961.93	.88	.01
Time 2					
1	13,480.82	13,531.011	13,492.92	—	—
2	12,248.70	12,328.16	12,267.86	.89	.002
3	11,761.46	11,870.19	11,787.67	.86	.21
4	11,562.05	11,700.06	11,595.32	.84	.04
5	11,402.75	11,570.03	11,443.07	.86	.26

Note. Em dashes indicate data not available. AIC = Akaike’s information criterion; BIC = Bayes’ information criterion; SSABIC = sample size-adjusted Bayes’ information criterion; LMR = Lo-Mendell-Rubin test.

Predictors of Profile Membership at Time 1

At Time 1, the classes significantly differed in race/ethnicity, maternal education, diploma tracks, and IQ, but not age or biological sex (see Table 5 for parameter estimates). Students in Low Literacy/Intensive Support were predominantly White and non-Hispanic (70.1%) compared to students in Emergent Literacy/Comprehensive Support (45.3%), Average Literacy/Moderate Support (39.4%), and Average Literacy/Limited Support (59.4%). Students in Emergent Literacy/Comprehensive Support had significantly more mothers reporting receipt of a high school diploma or below (25.8%) than those in Average Literacy/Moderate Support (18.7%), Low Literacy/Intensive Support (15.4%), and

Table 3. Descriptive statistics of latent profiles at Time 1 and Time 2.

Measure	Emergent Literacy/ Comprehensive Support		Low Literacy/ Intensive Support		Average Literacy/ Moderate Support		Average Literacy/ Limited Support	
	T1 M (SE)	T2 M (SE)	T1 M (SE)	T2 M (SE)	T1 M (SE)	T2 M (SE)	T1 M (SE)	T2 M (SE)
Autism Symptom Severity ^a	80.30 (2.17)	79.41 (1.18)	71.40 (1.89)	71.88 (1.01)	70.51 (2.14)	64.70 (1.61)	61.78 (0.97)	57.81 (1.83)
Receptive Language ^b	7.94 (0.52)	8.32 (0.23)	10.92 (0.43)	10.70 (0.30)	11.30 (0.13)	13.10 (0.60)	16.35 (0.16)	15.95 (0.19)
Expressive Language ^b	7.24 (0.44)	7.39 (0.23)	10.29 (0.77)	10.06 (0.24)	11.98 (0.17)	11.99 (0.32)	14.13 (0.25)	15.59 (0.44)
Written Language ^b	7.14 (0.64)	7.31 (0.29)	10.31 (0.78)	10.13 (0.21)	13.24 (0.50)	13.28 (0.39)	15.29 (0.30)	16.52 (0.37)
Passage Comprehension ^c	14.07 (5.10)	18.11 (3.00)	57.34(10.05)	63.90 (4.80)	91.74 (8.12)	90.84 (1.86)	89.60 (1.98)	96.49 (3.08)
Academic Knowledge ^c	19.92 (4.30)	22.63 (2.66)	60.29 (8.80)	63.88 (3.89)	92.87 (8.64)	90.14 (1.95)	89.48 (1.98)	97.88 (3.20)

Note. T1 = Time 1; T2 = Time 2.

^aSocial Responsiveness Scale–Second Edition *T* score. ^bVineland Adaptive Behavior Scales–Second Edition Teacher Report Form *v*-scale scores. ^cWoodcock–Johnson III Tests of Achievement Standard Scores.

Average Literacy/Limited Support (18.3%). Students in Average Literacy/Limited Support (92.7%) and Average Literacy/Moderate Support (84.4%) were in standard diplomatrack programs compared to those in Low Literacy/Intensive Support (24.5%) and Emergent Literacy/Comprehensive Support

(14.5%) who were predominately in the modified diploma track program. The Emergent Literacy/Comprehensive Support profile demonstrated the lowest nonverbal IQ scores ($M = 49.94, SE = 1.98$), followed by Low Literacy/Intensive Support ($M = 77.38, SE = 1.71$). Students in the

Figure 2. Latent profile analysis results at Time 1. SRS = Social Responsiveness Scale–Second Edition *T*-score; REC= Vineland Adaptive Behavior Scales–Second Edition Teacher Report Form (VABS-II TRF) Receptive *v*-scale score; EXP = VABS-II TRF Expressive *v*-scale score; WRT= VABS-II TRF Written *v*-scale score; PC= Woodcock–Johnson III Tests of Achievement Passage Comprehension standard score; AK= Woodcock–Johnson III Tests of Achievement Academic Knowledge standard score.

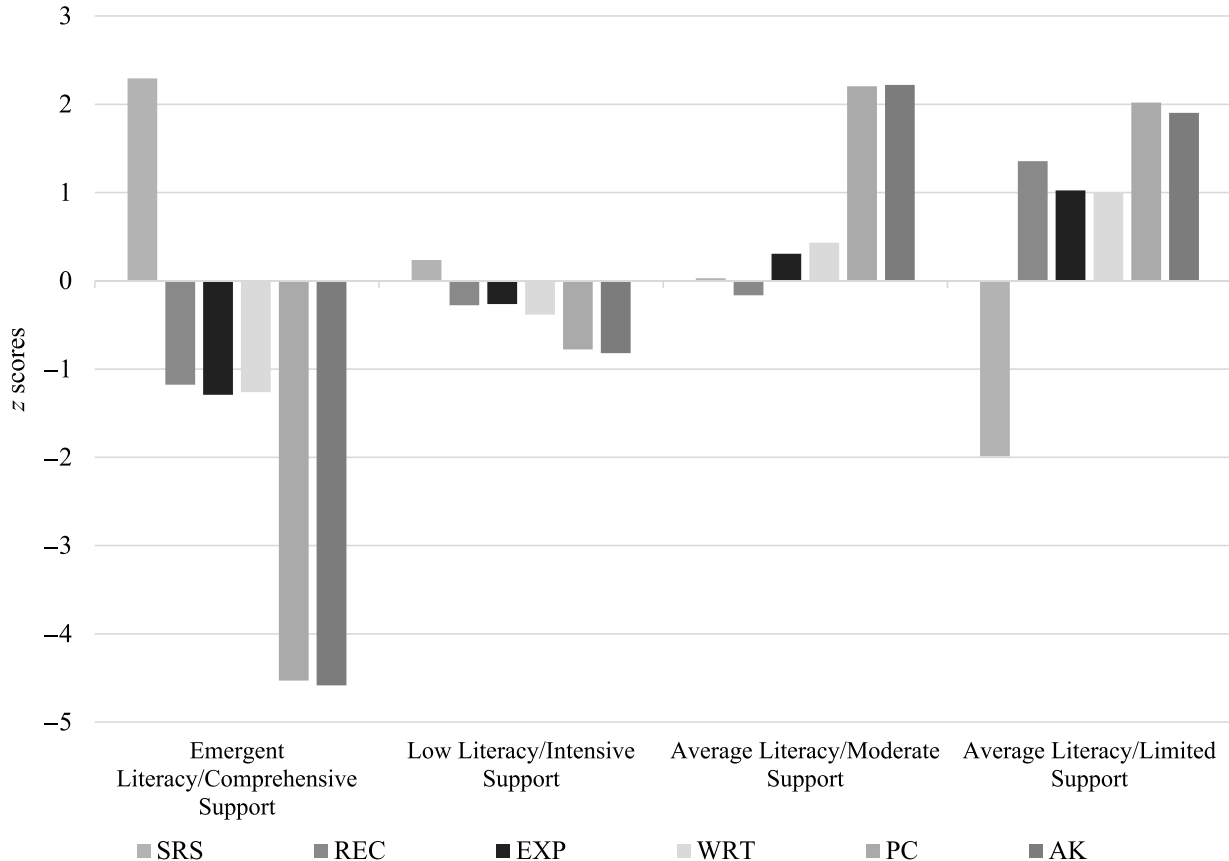
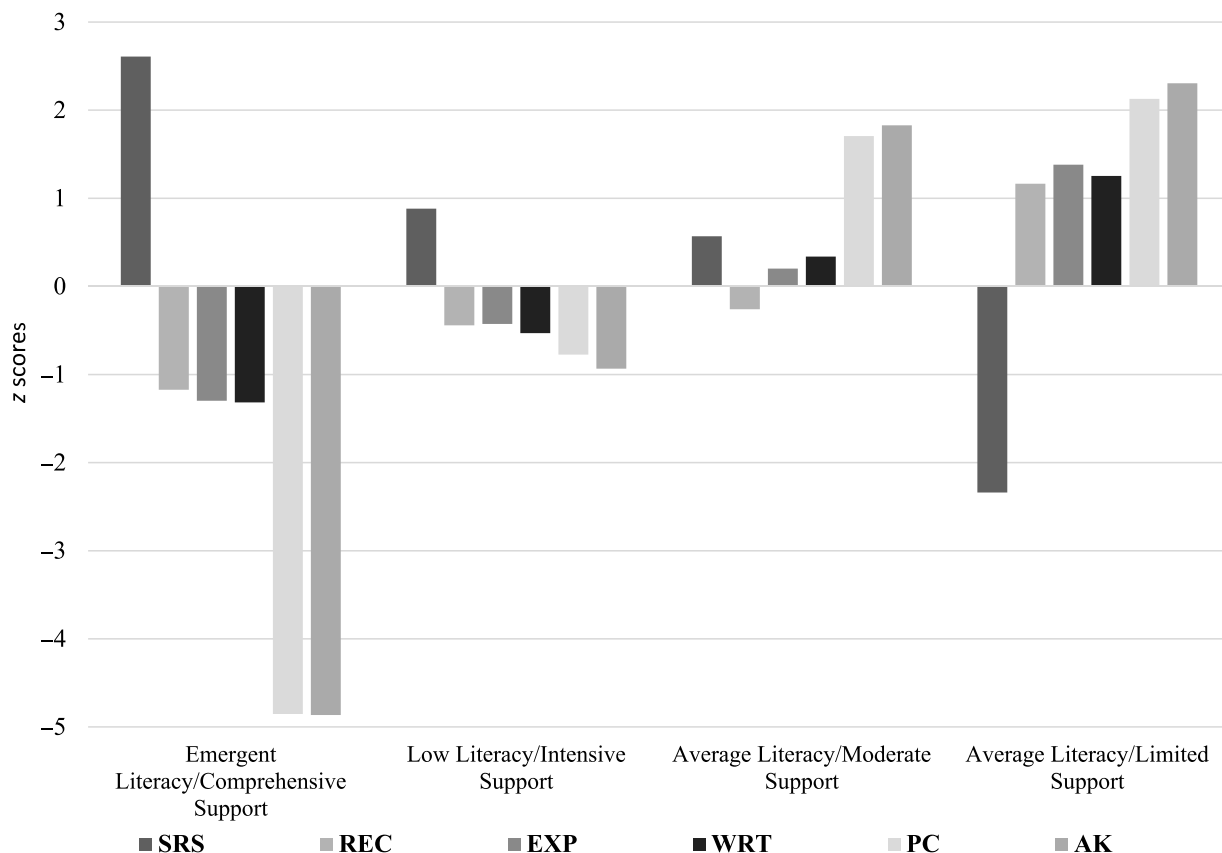


Figure 3. Latent profile analysis results at Time 2. SRS = Social Responsiveness Scale–Second Edition *T*-score; REC= Vineland Adaptive Behavior Scales–Second Edition Teacher Report Form (VABS-II TRF) Receptive *v*-scale score; EXP= VABS-II TRF Expressive *v*-scale score; WRT= VABS-II TRF Written *v*-scale score; PC = Woodcock–Johnson III Tests of Achievement Passage Comprehension standard score; AK = Woodcock–Johnson III Tests of Achievement Academic Knowledge standard score.



Average Literacy/Moderate Support ($M = 97.36, SE = 1.62$) and Average Literacy/Limited Support ($M = 104.53, SE = 1.60$) profiles had significantly higher IQs than those in the Low Literacy/Intensive Support and Emergent Literacy/Comprehensive Support profiles but did not significantly differ from each other.

Stakeholder Perception of Required School Support Intensity

Differences were examined across support needs at both time points by parents and teachers. See Supplemental

Materials S1 and S2 depicting latent profile groups support needs across both time points. Parents rated school participation supports as most intensive in both the Emergent Literacy/Comprehensive Support and Low Literacy/Intensive Support profiles, followed by significantly less support needs reported in the Average Literacy/Moderate Support and Average Literacy/Limited Support profiles as needing the least amount of support at both time points. Parents rated school learning activities as the most intensive support needs in the Emergent Literacy/Comprehensive Support profile, followed by the Low Literacy/Intensive Support, Average Literacy/Moderate Support, and Average

Table 4. Latent transition probabilities between profiles.

Profile	Emergent Literacy/ Comprehensive Support	Low Literacy/ Intensive Support	Average Literacy/ Moderate Support	Average Literacy/ Limited Support
Emergent Literacy/Comprehensive Support	1.00	.00	.00	.00
Low Literacy/Intensive Support	.00	.98	.000	.02
Average Literacy/Moderate Support	.00	.00	.91	.09
Average Literacy/Limited Support	.00	.05	.20	.77

Table 5. Predictor parameters of profile membership at Time 1.

Variable	Emergent Literacy/Comprehensive Support		Low Literacy/Intensive Support		Average Literacy/Moderate Support	
	Logit (SE)	OR [95% CI]	Logit (SE)	OR [95% CI]	Logit (SE)	OR [95% CI]
IQ	-.12 (0.02)**	0.89 [0.86, 0.91]	-0.05 (0.01)**	0.96 [0.94, 0.97]	-0.01 (0.01)	0.99 [0.98, 1.00]
Diploma track	3.27 (0.73)**	26.21 [7.90, 87.01]	2.94 (0.55)**	18.97 [7.62, 47.22]	0.59 (0.57)	1.81 [0.71, 4.58]
Intervention group	0.25 (0.62)	1.29 [0.46, 3.5]	-0.40 (0.43)	0.78 [0.38, 1.59]	-0.34 (0.31)	0.72 [0.43, 1.19]
Age	0.19 (0.16)	1.21 [0.93, 1.58]	0.29 (0.15)	1.33 [1.00, 1.70]	0.09 (0.13)	1.10 [0.88, 1.37]
Race/ethnicity	0.36 (0.47)	1.44 [0.66, 3.12]	0.50 (0.41)	1.64 [0.83, 3.24]	-0.58 (0.30)	0.56 [0.34, 0.92]*
Biological sex	0.46 (0.69)	1.58 [0.51, 4.91]	0.14 (0.46)	1.15 [0.54, 2.46]	0.34 (0.40)	1.41 [0.73, 2.70]
Maternal education	1.57 (0.67)*	4.79 [1.58, 14.50]	0.63 (0.48)	1.87 [0.85, 4.14]	-0.01 (0.36)	1.00 [0.55, 1.81]

Note. Reference profile is Average Literacy/Limited Support. OR = odds ratio; CI = confidence interval.

* $p < .05$. ** $p < .001$.

Literacy/Limited Support profiles at Time 1, with the Emergent Literacy/Comprehensive Support and Low Literacy/Intensive Support profiles not significantly differing at Time 2.

Teachers rated school participation supports as the most intensive support needs in the Emergent Literacy/Comprehensive Support profile, followed by the Low Literacy/Intensive Support, Average Literacy/Moderate Support, and Average Literacy/Limited Support profiles in decreasing order at both time points. Teachers did not rate the Emergent Literacy/Comprehensive Support and Low Literacy/Intensive Support profiles as significantly different in school learning activities support needs at Time 1, followed by the Average Literacy/Moderate Support and Average Literacy/Limited Support profiles. At Time 2, teachers rated the Emergent Literacy/Comprehensive Support profile as needing the most support in school learning activities, followed by the Low Literacy/Intensive Support, Average Literacy/Moderate Support, and Average Literacy/Limited Support profiles.

Discussion

Four unique literacy profiles emerged in this diverse sample of high school students with ASD that were relatively similar in size, stable over time, and associated with distinct predictors of profile membership and stakeholder perceptions of school participation and school learning support needs. The profiles are consistent with what is known about the connections between reading, language and cognitive skills, and symptom severity in students with ASD (e.g., Brown et al., 2013; Ricketts et al., 2013) as well as previous research reporting reading subgroups in students with ASD (Davidson & Ellis Weismer, 2014; McIntyre, Solari, Grimm, et al., 2017; Solari et al., 2019). However, this study extends the current literature since it focuses only on adolescents who exhibited a very broad range of cognitive abilities.

Students in the Emergent Literacy/Comprehensive Support profile had severe autism symptomatology; very low to moderately delayed nonverbal IQ; low receptive, expressive, and written language and communication skills; and very low reading comprehension and academic

knowledge scores near the floor of the assessment and were predominately on a modified diploma track. Consistent with performance on standardized assessments, both parents and teachers agreed that students in this profile required high levels of support for school participation and school learning activities, although teachers rated this profile's school support needs as more intensive than did the parent raters and they rated school participation supports for this profile as the most intensive support needs of all the profiles at both time points. This was the most stable profile over time, with only one student moving into the Low Literacy/Intensive Support profile. Based upon cognitive, language, reading comprehension, and academic knowledge scores, students in this profile can be conceptualized as emergent readers. This is consistent with research in children with significant intellectual disabilities who demonstrate reading and writing behaviors that precede and can develop into conventional reading and writing (Teale & Sulzby, 1986). Erickson et al. (2010) noted that emergent readers are still developing an understanding of print and its uses; they are in a stage where they can learn print conventions, phonological awareness, alphabetic knowledge, and foundational receptive and expressive language skills such as vocabulary and syntax as well as linguistic comprehension abilities such as narrative skills. Literacy level can be conceptualized as a continuum along which all readers may move, yet prior research has noted that the literacy needs of students with ASD and ID may not receive sufficient attention due to other significant challenges in behavior and communication (Paynter et al., 2016).

Individuals in the Low Literacy/Intensive Support profile had moderate autism severity; low nonverbal IQ; moderately low receptive, expressive, and written language and communication skills; and low reading comprehension and academic knowledge scores that were approximately 2.5 SDs below average and were predominately on a modified diploma track. On average, while both parents and teachers agreed that this profile required medium to high levels of support at school, teachers rated this profile's support needs as slightly less intensive than did the parent raters. This is not entirely consistent with scores on the standardized assessments, which indicated a need for substantial support

to develop literacy skills. This was the second most stable profile over time, with only 2% transitioning to the Average Literacy/Limited Support profile, which is less than that reported by Solari et al. (2019), who indicated that 10% of their mixed-deficit profile transitioned into a higher subgroup. Based upon cognitive, language, reading comprehension, and academic knowledge scores, students in this profile can be conceptualized as becoming readers in the conventional stage where word reading skills and linguistic comprehension skills are developing to allow at least some independent engagement with texts (Lanter & Watson, 2008). While word decoding skills were not measured in this study, this profile shares similarities with the mixed-deficit profiles McIntyre, Solari, Grimm, et al. (2017) and Davidson and Ellis Weismer (2014) reported with regard to global impairments in reading comprehension and receptive and expressive language that were associated with higher ASD symptomatology.

Students in the Average Literacy/Moderate Support profile had moderate autism severity; average nonverbal IQ; moderately low receptive, expressive, and written language and communication skills; and average reading comprehension and academic knowledge scores and were predominately on a standard diploma track. On average, while both parents and teachers agreed that this profile required lower levels of support at school than the two previous profiles, teachers rated this profile's school support needs as less intensive than did the parent raters. This was the third most stable profile over time, with 9% transitioning to the Average Literacy/Limited Support profile. Based upon cognitive, reading comprehension, and academic knowledge scores, students in this profile may be conceptualized as being in the skilled reading stage where they have adequate word reading skills and academic background knowledge to read and understand texts independently. However, it is notable that their language and communication scores, while higher than those in the Low Literacy/Intensive Support profile, were still in the moderately low to low adequate range. In addition, their ASD symptom severity was not different from the Low Literacy/Intensive Support profile. This moderate level of severity is clinically significant and likely to substantially interfere with everyday social interactions (Constantino & Gruber, 2012). These distinctions make this an interesting profile because standardized tests of academic achievement and IQ may not accurately depict the type and level of supports needed to support proficient literacy skills in typical high school classes. While they might appear to be similar to the students in the average reader profiles reported by McIntyre, Solari, Grimm, et al. (2017) and Davidson and Ellis Weismer (2014), in order to keep up with their peers, they may require additional evaluation to determine appropriate supports.

Individuals in the Average Literacy/Limited Support profile had mild autism severity; average nonverbal IQ; adequate receptive, expressive, and written language and communication skills; and average reading comprehension and academic knowledge scores, and they were almost exclusively on a standard diploma track. On average, while

both parents and teachers agreed that this profile required the lowest levels of support at school, teachers rated this profile's school support needs as less intensive than did the parent raters. This was the least stable profile over time, with 20% transitioning to the Average Literacy/Moderate Support profile and 3% transitioning to the Low Literacy/Intensive Support profile. This decline is notable, and future research should examine factors associated with students who worsen over time as compared to their peers. Based upon cognitive, language, reading comprehension, and academic knowledge scores, students in this profile may be conceptualized as being in the skilled reading stage where they have adequate word reading skills and academic background knowledge to read and understand texts independently. This group most resembles the average reader profiles reported in previous research (Davidson & Ellis Weismer, 2014; McIntyre, Solari, Grimm, et al., 2017). Their language and communication scores are higher, and ASD symptomatology is milder than those in the Average Literacy/Moderate Support profile, which one would expect would lead to more proficient literacy skills that would support engagement in typical high school classes.

Implications and Future Directions

To the best of our knowledge, this is the first exploration of literacy profiles in a large, diverse sample of high school students with ASD. This study revealed adolescent literacy profiles that span from emergent to average levels of reading ability. In general, parent and teacher reports of school learning support intensity aligned with the profiles indicating they are aware of the intensity of supports these students require. However, reporting stakeholder perceptions of school and learning support needs is just the first step in understanding how to provide literacy instruction and interventions that align with student needs. Future research should investigate specific types and intensities of services to promote literacy development in various subgroups.

Adolescents with greater reading comprehension and academic knowledge showed milder autism symptomatology and higher receptive, expressive, and written language skills and nonverbal IQ. This is not surprising given what we know about these relations in other samples (Davidson & Ellis Weismer, 2014; McIntyre, Solari, Grimm, et al., 2017; Ricketts et al., 2013; Solari et al., 2019). However, the Average Literacy/Moderate Support profile was an interesting exception. While their standardized reading comprehension and academic knowledge scores were in the average range, higher levels of ASD symptom severity and lower language and communication skills than those in the Average Literacy/Limited Support profile places them at risk for difficulties engaging in school-based learning opportunities in the same way as their peers requiring more limited supports. In fact, the students who remained in the Average Literacy/Moderate Support profile did not make standardized gains in reading comprehension or academic knowledge. However, those who remained in the Average

Literacy/Limited Support profile did make standardized gains on both assessments. Taylor and Seltzer (2011) described the sizable subgroup of young adults with ASD without comorbid ID in their study who had no daytime activities, as possessing more functional, or adaptive, independence than those who were receiving adult day services but less than those that were functionally independent in the community. While it is beyond the scope of this study, high school students in the Average Literacy/Moderate Support profile share some general characteristics with Taylor and Seltzer's young adult subgroup. More needs to be learned about improving outcomes for cognitively able high school students with ASD who display strengths on some standardized academic assessments but who may need specialized supports related to their social communication and ASD-specific behavioral needs.

Previous work examining reading profiles in school-age readers with ASD indicated that, when a comprehensive battery of language and reading skill assessments are administered, a nuanced picture of strengths and weaknesses emerges, and these differentiated profiles are relatively stable over time (McIntyre, Solari, Grimm, et al., 2017; Solari et al., 2019). Future research to support literacy intervention outcomes for adolescents with ASD should investigate modifiable predictors to be included in assessment batteries. Other research to support intervention outcomes should investigate collaboration between, and delineation of the roles of, members of multidisciplinary school teams. For example, speech-language pathologists (SLPs) have critical and complementary skills to contribute to multidisciplinary school teams composed of general and special educators, literacy specialists, and school psychologists in the identification and support of literacy challenges in adolescents with ASD. As specialists with expertise in language, SLPs can play a key role in promoting literacy competencies across core content areas while also working on fundamental language skills and strategies for students with reading challenges (Ehren et al., 2012). The need for SLP-educator collaborations is recognized with the American Speech-Language-Hearing Association's Professional Issues Statement, "Roles and Responsibilities of Speech-Language Pathologists in Schools" (ASHA, 2010), with evidence from studies of SLP-educator collaborations reviewed in Archibald (2017). SLPs can collaborate with educators in many ways that extend from planning, implementation, and progress monitoring of language and literacy instruction in general education settings to specialized assessment and intervention. In light of the heavy language demands of the CCSS across content areas, the SLP is an invaluable partner in promoting growth in language and literacy skills for students with ASD.

In addition, future research designed to probe similarities and differences between the reading profiles and their stability reported here and those of other populations such as those with dyslexia or other developmental disabilities would inform assessment and intervention. Finally, to provide insight into the contribution of language and culture to reading comprehension in this population, future

research should be conducted on reading and ASD in languages other than English.

Limitations

This study has several limitations. This analysis was conducted within the context of a randomized control trial, and the intervention could have affected the results. However, there was no main effect of intervention group on profile membership, and for three of the four profiles, analyses did not indicate a significant effect on transition among profiles due to grouping at Time 2. With regard to the five students who transitioned up from low literacy group, this could be representative of reduction in autism symptoms and improvement in language abilities but could also be that the teacher who was rating them at the second time point was not the same teacher at the first time point. This small group of students represents the significant need for continued and reliable assessment to ensure that the right supports, and programs are provided. A related limitation of this study is that language proficiency is based on teacher report rather than direct assessment. While there are many methodological benefits to direct assessment with standardized measures, as Pickles et al. (2014) noted, the Vineland has strengths related to assessing language in a natural context. Furthermore, they reported substantial agreement between expressive and receptive language reports on the Vineland with direct assessment measures in their sample.

Finally, a lack of reading measures such as word decoding and/or reading fluency in this study limited direct comparisons to prior studies of reading subgroups in ASD, since a poor comprehender profile could not be identified or followed longitudinally. Furthermore, the presence of these measures would have provided additional information to inform the development of assessment batteries; future research should include comprehensive reading and language batteries.

Conclusions

The four profiles outlined in this study are an attempt to parse some of the extensive heterogeneity present among high school students with ASD into more homogenous literacy subgroups with similar support intensity needs. Understanding the specific types and levels of supports to provide students with ASD in order to improve literacy outcomes is a large but critical undertaking that requires targeted assessment and multidisciplinary teams of SLPs, educators, and other professionals. More research in this area is needed to accomplish these goals.

Author Contributions

Nancy S. McIntyre: Conceptualization (Lead), Formal analysis (Supporting), Writing – original draft (Equal). **Brianne Tomaszewski:** Formal analysis (Lead), Writing – original draft (Equal). **Kara A. Hume:** Funding acquisition (Equal), Investigation (Equal), Project administration (Equal).

Samuel L. Odom: Funding acquisition (Lead), Investigation (Lead), Project administration (Supporting).

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