Academic skills in children with autism spectrum disorders with monolingual or bilingual experience

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Abstract
Background and aims: The academic development of children with autism spectrum disorders is important to investigate as it can provide opportunities for higher education, independent living, and successful employment in adulthood. Although educational data find that children with autism spectrum disorders can achieve similar levels of academic achievement in inclusive settings as neurotypical children, little is known about how children with diverse language experiences with autism spectrum disorders develop academically. Research on neurotypical, bilingual children finds that although many may lag behind their monolingual peers on measures of academic achievement, these gaps can be minimized with bilingual education programs. Within clinical practice, concerns are still raised about bilingual exposure in children with autism spectrum disorders, with assumptions and recommendations made to limit the language of exposure to minimize risks to development. To improve the evidence-base on bilingual experience in children with autism spectrum disorders, the present study will examine whether basic academic skills (i.e., word reading, numerical operations, spelling) vary as a function of language experience (i.e., monolingual vs. bilingual).

Methods: The data presented in this study were based on medical records of children with autism spectrum disorders who visited a clinic in a large, urban city in the United States. Records were included for this study if children had information/data on language status, nonverbal cognition, and standardized scores for reading, math, and spelling on a standardized academic achievement test. The final sample included children with autism spectrum disorders with monolingual language experience (n = 18) or bilingual language experience (n = 13).

Results: Repeated measures analysis of variance analyses found that children with autism spectrum disorders with monolingual experience had higher scores on word reading skills when compared to children with autism spectrum disorders with bilingual experience. However, a different pattern was found for numerical operations, with children with autism spectrum disorders with bilingual experience outperforming children with autism spectrum disorders with monolingual experience. No differences were found between groups on spelling skills.

Conclusions: The preliminary findings suggest that bilingual language experience may be related to early literacy and math skills in children with autism spectrum disorders. It may be that word reading skills are slower to develop among children with autism spectrum disorders with bilingual experience due to the development of two linguistic profiles. Math skills may be enhanced in children with autism spectrum disorders with bilingual experience through the mediation of other cognitive skills (e.g., executive functioning).

Implications: This preliminary study demonstrates that bilingual experience does not negatively affect the development of academic skills in children with autism spectrum disorders. Further exploration of how bilingual experience may benefit children with autism spectrum disorders is needed.

Keywords
Autism spectrum disorders, bilingualism, reading, literacy, education

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Research on children with autism spectrum disorders (ASD) has expanded significantly in recent years, providing a greater awareness and recognition of the vast diversity within ASD. Historically, children with ASD from culturally diverse backgrounds have not been well represented in research studies. Yet many research studies have found significant disparities in the identification, diagnosis, and services among this population (Jo et al., 2015; Magaña, Lopez, Aguinaga, & Morton, 2013; Mandell, Listerud, Levy, & Pinto-Martin, 2002; St. Amant, Schrager, Peña-Ricardo, Williams, & Vanderbilt, 2018). Identifying these disparities has resulted in increased efforts to better understand the unique needs and experiences of culturally diverse children with ASD and their families (Engstrand, Klang, Hirvikoski, Allodi, & Roll-Petersson, 2018; Khanlou et al., 2017; Yingling, Hock, & Bell, 2018). Research on linguistic diversity in ASD has also increased since 2012, with most studies recognizing the need to understand the development of children with ASD who are exposed to and learn multiple languages. Although there is a growing body of research investigating the influence of bilingual language experience on language and communication development in children with ASD (see Drysdale, van der Meer, & Kagohara, 2015 and Lund, Kohlmeier, & Duran, 2017 for reviews, and Lim, O’Reilly, Sigafos, & Lancioni, 2018 for a commentary), little is known about the influence of bilingual language experience on other areas of functioning, specifically academic development. Academic skills are important to study given that these skills can set the stage early on for long-term success (or challenges) in children with ASD (Kim, Bal, & Lord, 2018). The current research study examines basic academic skills in children with ASD who have monolingual or bilingual experience through a retrospective record review.

**Academic skills in children with ASD**

Children with ASD can process information in a distinctive manner from neurotypical (NT) children. Several studies have shown that children with ASD tend to focus on detailed information as this information may be processed more efficiently (Miller, Odegard, & Allen, 2014). The variations in cognitive processing can therefore affect how academic instruction is received and processed in children with ASD. A recent review by Keen, Webster, and Ridley (2016) reported that children with ASD present a varied profile of academic skills, with specific areas of strengths and weaknesses. The variations in findings were challenging to decipher as many studies did not report on the educational settings of children with ASD (e.g., special education classroom, partial inclusion), including a range of sources of information (e.g., parent report, teacher report, academic reports), and had a broad range of research objectives (e.g., characterizing academic performance in ASD). Although academic achievement is associated with cognitive abilities in children with ASD (Mayes & Calhoun, 2008), there may be other factors beyond cognitive abilities or IQ that affect the acquisition and development of academic skills. For example, Mayes and Calhoun (2003) found that despite high IQ (IQ > 80), children with ASD still exhibited difficulties in working memory, arithmetic, and writing skills. Jones et al. (2009) also found distinct cognitive profiles in ASD as demonstrated through peaks in valleys in reading and mathematical abilities. These studies suggest that academic development in ASD can be quite heterogenous, with more research needed to incorporate diverse samples as most studies have focused on younger children with higher IQ or cognitive ability.

Other factors may influence the academic trajectories of children with ASD. For example, Estes et al. (2011) found that greater social skills in six-year-old children with ASD were predictive of greater academic skills in the same children at nine years of age. Other studies have found an association with social and communication skills and reading comprehension skills in adolescents with ASD (Jones et al., 2009). Some studies suggest that increased executive function (EF) skills contribute to the acquisition and development of academic skills. In a longitudinal study Pellicano et al. (2017) found that EF skills predicted school readiness skills among five- to six-year-old children with ASD. This association (EF and academic skills) is of particular interest, considering the extensive literature on greater EF skills among bilingual TD children (see Bialystok, 2015, for a review). Thus, it is possible that bilingual experience may further enhance the academic skills of children with ASD through the enhancement of EF skills. The extensive research investigating the role of bilingual experience on academic development in children without ASD may serve as a framework for considering the influence that bilingual experience may have on the academic development of children with ASD.

**Academic skills in NT bilingual children**

Despite the limited research on bilingual children with ASD, there is a significant body of research on bilingual, NT children. Research finds that NT children who are English-language learners (ELL) may lag behind their monolingual peers on measures of academic achievement, including reading and math skills (Han, 2012; Melby-Lervåg & Lervåg, 2014). Research suggests that for bilingual children or ELL, slower development in one language may affect children’s ability to capitalize on their unique language experience across reading
comprehension tasks (Schoonen et al., 1998). Thus, some suggest that biliteracy is critical for bilingual children to demonstrate comparable reading skills to monolingual children (Adesope, Lavin, Thompson, & Ungerleider, 2010; Bialystok, 1999). Despite the findings that bilingual children or ELL may underperform on reading and math tasks when compared to monolingual children, math skills may be uniquely protected among bilingual, NT children. In a meta-analysis of over 60 studies, Adesope et al., (2010) found that bilingual children were afforded greater symbolic and abstract representation skills. These findings suggest that bilingual experience may exert unique contributions on reading and math skills due to the underlying cognitive skills required.

Substantial research with bilingual NT children has focused on EF skills, including shifting, updating and monitoring, and inhibition (Bialystok, Craik, Green, & Gollan, 2009). These studies have found that the degree of bilingual language exposure can result in incremental cognitive benefits in children and older adults (Poarch & Van Hell, 2012). Additionally, gains in EF (i.e., working memory) and high language proficiencies across both languages in bilingual NT children predicted gains in math skills, even among bilingual children with significant math difficulties (Blair & Razza, 2007; Bull, Espy, & Wiebe, 2008; Swanson, Kong, & Petcu, 2018). These findings suggest a complex relationship between bilingual language learning, EF, and academic development in NT children. Although the research on bilingual, NT children and academic achievement is important to consider, the developmental experience may be distinct from bilingual children with ASD.

Development of bilingual children with ASD

To date, no studies have examined the development of academic skills in children with ASD who have bilingual experience. Thus, it is unclear whether the research findings from children with ASD with monolingual experience or NT children with bilingual experience will extend to children with ASD who have bilingual experience. Although no studies have directly investigated academic skills in bilingual children with ASD, researchers have investigated the relationship between bilingualism in children with ASD and their social communication skills. However, the findings reported are inconsistent across the literature.

In a large study from Canada, preschool children with ASD (age three to five years) who had bilingual experience from birth were reported to have greater interpersonal skills when compared to children with ASD with bilingual experience after 12 months of age and children with ASD with monolingual experience (Hambly & Fombonne, 2012). Although the authors did not provide an interpretation of this finding, it may be that early bilingual experience affords children with ASD additional opportunities for social interaction and thus boosts the development of interpersonal skills. More recently, Iarocci, Hutchison, and O’Toole (2017) assessed the role of second language exposure on functional communication and EF skills among school-age children with and without ASD (age 6–16 years). Based on parent ratings of functional communication, the authors found no significant differences between children with ASD with and without second language exposure; however, both groups were reported to have lower functional communication skills than typically developing children with and without second language exposure. These results suggest that second language exposure may not have a significant effect on the functional communication of children with ASD as reported by parents.

Other recent studies from Canada have also explored EF in children with ASD with a range of bilingual experience. One study specifically assessed verbal fluency, a skill that taps into both language and EF skills, among 5- to 10-year old children with ASD with bilingual experience (Gonzalez-Barrero & Nadiq, 2017). This study reported that children with ASD with bilingual experience outperformed children with ASD with monolingual experience, with bilingual children with ASD accessing and producing more words during the allotted time frame than monolingual children with ASD. Building on this finding, Gonzalez-Barrero and Nadiq (2019) further explored set-shifting skills among children with ASD with monolingual language experience. The findings from this latter study also found that children with ASD with bilingual experience demonstrated significant advantages in set-shifting skills when compared to monolingual children with ASD, but only on an experimental task.

Thus far, research with children with ASD with bilingual experience demonstrates that early cognitive development (i.e., vocabulary development, pretend play) may be advantaged for some children with ASD with bilingual experience (i.e., bilingual experience from infancy). Given the positive influence that bilingualism has on academic skill development in NT children, it is important to determine whether this same influence is observed in bilingual children with ASD.

Current study

The current study investigates basic academic skills (i.e., reading, math, spelling) among children with ASD with diverse language experiences (monolingual,
bilingual). Based on the research thus far on bilingual NT children and bilingual children with ASD, it is hypothesized that children with ASD with bilingual experience will exhibit lower reading and spelling skills than children with ASD with monolingual experience. No differences are expected between language groups on math skills.

**Methods**

**Participants**

Children with ASD were selected from a larger retrospective medical record review study. Medical records were drawn from a developmental disabilities clinic in Chicago, Illinois, United States. In 2012, the U.S. Census Bureau estimated that African American, Latino, Asian, and other ethnic and racial minorities comprised 55% of Chicago's population (vs. 29% nationally). Illinois is now home to almost 700,000 Mexican immigrants, with significant populations from Poland, India, Philippines, and China (Illinois Coalition of Immigrant and Refugee Rights, 2011). The large diversity of the population provides a unique opportunity to examine diverse language experiences among children with ASD. The developmental disabilities clinic served patients from culturally and socioeconomically diverse backgrounds and was one of a few medical clinics in the region that accepted public insurance (i.e., Medicaid) for diagnostic evaluations and therapeutic services. All evaluations for ASD were conducted by an interdisciplinary team comprised of speech–language pathologists, occupational therapists, social workers, counselors, clinical psychologists, and developmental/behavioral pediatricians.

The medical record review included children who were evaluated between 2004 and 2014 and who were between 3 and 12 years of age at the time of their evaluations. Additionally, only children who underwent an ASD evaluation and received an ASD diagnosis at that time or had an ASD diagnosis (or educational classification of Autism) prior to their evaluation were eligible for review. Overall, 31 cases met eligibility criteria and had data available for all measures listed below.

**Measures**

**Demographic characteristics.** Children’s age at the time of their assessment, their gender, and their racial/ethnic group identification, and the child’s insurance status (public or private) were extracted from the clinic intake documentation. Additional information about the level of maternal education (high school or less, some college, or higher) for each child was derived from the qualitative reports included in the child’s medical record. Demographic characteristics of the children included in this study are presented in Table 1.

**Clinical characteristics.** Children’s clinical characteristics were obtained through extensive review of the child’s medical records. This included reviewing the reports developed for the current evaluation and any records that were obtained from other sites (e.g., clinics, hospitals, schools). These reports were reviewed to obtain information about the child’s past and current diagnoses and results for any assessment measures conducted. Qualitative and quantitative data, including scores for diagnostic assessment tools, rating scales, and child assessment tools, were all abstracted from the medical records for inclusion into the dataset. Clinical diagnoses were included if they were made by a physician, psychologist, or other qualified professional (e.g., speech–language pathologist). Adaptive behavior was measured with the Vineland Adaptive Behavior Scales (VABS; Sparrow et al., 1984; 2005) for most children in the sample. Bilingual children with ASD were reported to have greater daily living skills than monolingual children with ASD, \[ t(18) = -2.49, p = .023 \]; no significant group differences were found in communication, \[ t(18) = -0.18, p = .863 \], or socialization skills, \[ t(18) = -2.04, p = .056 \]. Data for the VABS communication, daily living skills, and socialization subscales are presented in Table 1.

**Language experience.** Children’s language experience was documented through a review of the qualitative information included within the medical record. The information was reviewed to identify any languages spoken in the child’s home, school, and other environments, whether the child understood those languages, whether the child spoke those languages, and when available, any data from language assessments that were administered. This information was then used to determine whether the child had monolingual or bilingual experience. Monolingual experience was defined as consistent exposure to only one language across all settings (\( n = 18 \)). All children with monolingual experience were exposed to and spoke English only. Bilingual experience was defined as consistent exposure to two languages inclusive of all settings (\( n = 13 \)). Children with bilingual experience understood and/or spoke English and one other language, consisting of Spanish (\( n = 11 \)), Slovak (\( n = 1 \)), or Italian (\( n = 1 \)). All bilingual children spoke and were exposed to their native language in the home.

**Language functioning.** For some children in the sample, measures of receptive and expressive vocabulary knowledge were administered; however, this data were not available for all children in the sample.

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**Table 1**

| Language Experience | Monolingual | Bilingual |
|--------------------|------------|----------|
| Spanish            | 11         | 1         |
| Italian            | 1          | 1         |
| Portuguese         | 1          | 1         |
| German             | 1          | 1         |
| French             | 1          | 1         |
| Russian            | 1          | 1         |
| Polish             | 1          | 1         |
| Dutch              | 1          | 1         |
| Norwegian          | 1          | 1         |
| Swedish            | 1          | 1         |
| Finnish            | 1          | 1         |
| Total              | 18         | 13        |
Assessment measures for receptive vocabulary included the Peabody Picture Vocabulary (PPVT; Dunn & Dunn, 1997, 2007) and the Receptive One-Word Picture Vocabulary Test (ROWPVT; Brownell, 2000b; Martin & Brownell, 2011b). Assessment measures for expressive vocabulary included the Expressive Vocabulary Test (EVT; Williams, 1997, 2007) and the Expressive One-Word Picture Vocabulary Test (EOWPVT; Brownell, 2000a; Martin & Brownell, 2011a). The receptive and expressive vocabulary measures (PPVT, ROWPVT, EVT, EOWPVT) all have mean scores of 100 and standard deviations of 15.

All assessments were administered in English and reflect children’s English-language vocabulary knowledge. No differences were found between monolingual and bilingual children with ASD on receptive vocabulary, t(11) = 0.82, p = .429, or expressive vocabulary t(14) = 1.11, p = .284. Group means are presented in Table 1.

### Table 1. Characteristics of monolingual and bilingual children with autism spectrum disorders (ASD).

| Child characteristics                  | Monolingual (n = 18) | Bilingual (n = 13) |
|----------------------------------------|----------------------|-------------------|
| Child age (M (SD)/%) Range             | 8.4 (2.1) 5.50–11.58 | 7.6 (1.8) 5.50–11.25 |
| Age at first ASD diagnosis (M (SD)/%) Range | 6.4 (2.7) 2.08–11.58 | 5.7 (2.4) 2.25–10.50 |
| Gender (% male)                        | 72.2%                | 84.6%             |
| Race/ethnicity***                     |                      |                   |
| White (%)                             | 38.9%                | 15.4%             |
| Latino (%)                            | 5.6%                 | 84.6%             |
| African American (%)                  | 55.6%                | 0.0%              |
| Cognitive functioning                 |                      |                   |
| Verbal IQ (M (SD)/%) Range            | 77.82 (23.77) 49–126 | 70.70 (13.52) 47–89 |
| Nonverbal IQ (M (SD)/%)               | 83.72 (18.19) 52–117 | 92.85 (16.73) 61–125 |
| Full-scale IQ (M (SD)/%)              | 77.06 (19.22) 45–115 | 81.91 (12.40) 57–107 |
| Communication (M (SD)/%)              | 76.27 (10.28) 59–92 | 77.22 (14.06) 54–97 |
| Daily living skills                   | 74.18 (8.83) 58–89  | 87.44 (14.80) 66–117 |
| Socialization (M (SD)/%)              | 69.82 (8.72) 53–85  | 77.56 (8.10) 66–94 |
| Standardized language assessment      |                      |                   |
| Receptive vocabulary (M (SD)/%) Range | 86.70 (19.96) 61–120 | 76.00 (19.00) 60–97 |
| Expressive vocabulary (M (SD)/%)      | 80.67 (12.87) 61–102 | 72.25 (13.89) 55–87 |
| Age of first word (M (SD)/%)          | 1.75 (0.87) 0.58–3.00 | 2.00 (1.12) 0.67–4.00 |
| Age of phrase speech (M (SD)/%)       | 2.67 (0.74) 1.50–3.50 | 3.92 (1.20) 3.00–6.00 |
| First language learned (% English)    | 100.0%               | 23.1%             |
| English spoken in home (%)            | 100.0%               | 69.2%             |
| Other language spoken in home (%)     | 0.0%                 | 100.0%            |
| Native language supports in school (% Yes) | 0.0%              | 30.8%             |
| Maternal age at birth (M (SD)/%)      | 27.4 (4.8) 19–37     | 30.2 (5.0) 20–36  |
| Maternal education (% HS grad or less)| 22.2%                | 46.2%             |
| Insurance (% public aid/no insurance) | 61.1%                | 84.6%             |

Note: Age is presented in years; *p < .05; **p < .01; ***p < .001; Sample size is varied for the Monolingual (M) and Bilingual (B) groups as indicated: *M (n = 17; B n = 10); **M (n = 18; B n = 11); ***M (n = 11; B n = 9); 1st language learned (% English) in category: *M (n = 11; B n = 3); 1st language spoken in home in category: *M (n = 12; B n = 4); **M (n = 13; B n = 12); 1st language spoken in home in category: *M (n = 8; B n = 6).

### Cognitive functioning

Measures of nonverbal cognitive skills were obtained for all children with ASD from the medical records. Children included in this sample were administered distinct standardized assessment tools due to the range in chronological age and developmental level. Assessment tools included Wechsler Preschool and Primary Scale of Intelligence-3 (n = 8, Wechsler, 2002), the Wechsler Intelligence Scale for Children (4th edition n = 18; Wechsler, 2003), Differential Ability Scales-II (n = 3; Elliott, 2007), the Leiter International Performance Scale–Revised (n = 1; Roid & Miller, 1997), and the Stanford Binet-5 (n = 1; Roid, 2003). Although these standardized tests capture nonverbal cognitive skills in different ways, they provide a basis for understanding children’s nonverbal cognitive skills. Standard scores were obtained from all standardized tests, which are based on a standard mean of 100 and standard deviation of 15. No significant differences in the type of standardized test.
administered for nonverbal IQ were found between children with ASD with monolingual and bilingual experience, $\chi^2(4, n = 31) = 4.5, p = .344$. Additionally, no significant differences were found in nonverbal IQ scores between children with ASD with monolingual experience and children with ASD with bilingual experience, $t(29) = -1.4, p = .165$. Standard scores for the Verbal IQ and Full-Scale IQ measures, when available, for monolingual and bilingual children with ASD are presented in Table 1. No significant group differences were found for Verbal IQ and Full-Scale IQ.

**Academic skills.** Data from the Wechsler Individual Achievement Test (WIAT-II/WIAT-III; Wechsler, 2001, 2009) were extracted from the medical records as the measure of academic skills. The WIAT is a standardized assessment that taps into a broad range of academic skills, including word reading, basic math, spelling, reading comprehension, and writing. The WIAT-II and WIAT-III were both in use during the retrospective review, thus data were consolidated for analyses. Both editions have adequate internal consistency (WIAT-II: $z > .85$; WIAT-III: $z = .91$–.98) and test–retest reliability (WIAT-II: $r > .85$; WIAT-III: $r > .80$). Standard scores for the Word Reading, Numerical Operations, and Spelling subtests were collected. These subtests were selected as they represented the basic academic skills most appropriate across the age range of participants. The WIAT was administered in English to all children. Only children who had standard scores available for all three subtests and used spoken language to communicate were included in the analyses (monolingual $n = 18$, bilingual $n = 13$). The monolingual group consisted of children who spoke English; the bilingual group consisted of children who spoke English and spoke and/or understood Spanish, Slovak, or Italian. Data were available for additional WIAT subtests; however, data were not available for the entire sample. Data for these additional WIAT subtests are presented in Table 2.

### Table 2. Additional Wechsler Individual Achievement Test Subtests for monolingual and bilingual children with autism spectrum disorders (ASD).

| WIAT subtests                  | Monolingual M (SD) Range | Bilingual M (SD) Range |
|-------------------------------|--------------------------|------------------------|
| Pseudoword decoding$^a$       | 95.88 (16.72) 65–115     | 96.80 (22.83) 61–122   |
| Reading comprehension$^b$     | 90.00 (18.01) 64–120     | 75.71 (16.52) 41–87    |
| Math reasoning$^c$            | 82.79 (27.45) 40–117     | 82.50 (22.21) 50–106   |
| Written expression$^d$        | 88.11 (18.79) 62–114     | 97.00 (0.00) 97–97     |
| **WIAT composite**            |                          |                        |
| Reading composite$^e$         | 95.80 (15.37) 75–112     | 86.00 (34.70) 40–142   |
| Mathematics composite$^f$     | 77.10 (30.58) 40–120     | 78.50 (21.32) 50–104   |
| Written language composite$^g$| 88.00 (20.52) 56–115     | 84.67 (19.63) 62–96    |

WIAT: Wechsler Individual Achievement Test.

Note: Sample size is varied for the Monolingual (M) and Bilingual (B) groups as indicated: $^a(M n = 8; B n = 5)$; $^b(M n = 8; B n = 7)$; $^c(M n = 14; B n = 6)$; $^d(M n = 9; B n = 2)$; $^e(M n = 5; B n = 6)$; $^f(M n = 10; B n = 6)$; $^g(M n = 8; B n = 3)$.

#### Results

Standard scores for the WIAT Word Reading, Numerical Operations, and Spelling subtests were reviewed to check for skewness and kurtosis. Overall, the data across all subtests were found to be within the acceptable range for skewness from $-1.35$ to $0.76$ (SE = $0.54$–$0.62$) and acceptable range of kurtosis from $-0.81$ to $2.26$ (SE = $1.04$–$1.19$) for monolingual and bilingual children with ASD. Initial analyses evaluated the demographic characteristics of children with ASD across monolingual and bilingual experience groups. Independent samples $t$-tests were run on continuous variables: Child age, age of diagnosis, maternal age at time of birth, and nonverbal IQ. Chi-square analyses were run on categorical variables: Gender, race/ethnicity, maternal education, and insurance status. These analyses found no differences between children with ASD with monolingual or bilingual experience in child age at WIAT assessment, $t(29) = 1.2, p = .249$, age of first ASD diagnosis, $t(29) = 0.7, p = .482$, maternal age at time of child’s birth, $t(29) = -1.6, p = .130$, and nonverbal IQ, $t(29) = -1.4, p = .165$. Additionally, no differences were found between language groups on child gender, $\chi^2(1, n = 31) = 0.6, p = .667$, maternal education, $\chi^2(1, n = 31) = 0.2, p = .247$, or insurance status, $\chi^2(1, n = 31) = 2.0, p = .237$. Significant differences did emerge between groups on race/ethnicity, $\chi^2(2, n = 31) = 20.8, p < .001$, with more children with ASD...
with bilingual experience from Latino backgrounds than children with ASD with monolingual experience. Cook’s distance was calculated for data points within each subtest to examine the presence of outliers. Cook’s distance values were all below one, suggesting no outliers were present (Cook & Weisberg, 1982).

To examine similarities and differences in academic skills between monolingual and bilingual experience groups, a repeated measures analysis of variance (ANOVA) was conducted with WIAT Subtests as the within-subject variable and Language Group as the between-subjects variable. This analysis resulted in a significant WIAT Subtest × Language Group interaction, \( F(2, 58) = 3.4, \, p = .039, \) partial \( \eta^2 = .106. \) Follow-up tests indicated that although monolingual children performed higher than bilingual children on the Word Reading subtest, bilingual children performed higher on the Numerical Operations subtest than monolingual children, \( p = .033. \) These findings indicate that children with ASD who have monolingual experience outperform children with ASD with bilingual experience on basic reading skills, but not basic math skills. No differences emerged between language groups on basic spelling skills (Figure 1).

**Discussion**

Most early studies of bilingualism in ASD have conducted interviews with or surveys of parents (Bird, Lamond, & Holden, 2012; Hampton, Rabagliati, Sorace, & Fletcher-Watson, 2017); however, more recent studies have examined vocabulary development (Hambly & Fombonne, 2012; Petersen, Marinova-Todd, & Mirenda, 2012), functional communication (Chaidez, Hansen, & Hertz-Picciotto, 2012), early play skills (Valicenti-McDermott et al., 2012), EF (Gonzalez-Barrero & Nadiq, 2017, 2019; Iarocci, Hutchison, & O’Toole, 2017), and social skills (Hambly & Fombonne, 2012). Despite the limited research, two systematic literature reviews have also provided foundational knowledge on the impact of bilingualism on ASD (Drysdale, van der Meer, & Kagohara, 2015; Lund et al., 2017). The results of these studies have contributed to an emerging profile indicating that children with ASD who have bilingual experience present a similar profile across language and EF skills when compared to children with ASD who have monolingual experience, with some findings suggesting that under certain conditions, some advantages may emerge for children with ASD with bilingual experience. Given the limited research that has been published to date on the impact of bilingual experience on children with ASD, the current study examined the development of academic skills in children with ASD who have either monolingual or bilingual language experience.

Overall, the preliminary findings presented here suggest that reading may be affected in children with ASD with bilingual experience. Studies of typical development find that literacy may be influenced by literacy practices within the language, with little cross-language transfer (Bialystok & Herman, 1999). Children with ASD with bilingual experience may experience greater challenges in identifying the correct
phonemes associated with English words, however, in a subset of children in our sample, phonemic processing was relatively unaffected. Difficulties in word reading may also be attributed to challenges in word retrieval or lexical access. However, this interpretation would contradict the findings by Gonzalez-Barrero and Nadiq, (2017), showing that bilingual children with ASD retrieved more words within an allotted period of time. Further investigations are needed to determine the underlying cognitive processes and literacy practices that influence word reading skills among bilingual children with ASD.

Furthermore, these preliminary findings also suggest that bilingual experience may afford children with ASD certain advantages in basic mathematical skills. Choi, Rouse, and Ryu (2018) found that despite significant gaps in reading and math skills upon Head Start entry between monolingual and bilingual NT children, the gaps in math skills disappeared by Kindergarten (~2 years later), whereas the gaps in reading skills persisted. This suggests that math skills may be more malleable in early childhood education, whereas reading skills may require a longer investment in direct instruction in both languages to result in significant change for bilingual children (August & Shanahan, 2006; Bialystok, 2018).

These results are particularly relevant to families and professionals, as recommendations to maintain English-only households are still prevalent (Bird et al., 2012; Lim et al., 2018), yet these recommendations often result in feelings of loss, decreased communication in the home, and isolation from their community (Garcia et al., 2012). Thus, changes are needed to address assumptions about the impact of bilingual language experience on children with ASD and other disabilities. These findings can inform educational policies to ensure that children with ASD with bilingual experience receive equitable services and supports for their academic development (Bialystok, 2018).

Gaps in academic skills between monolingual and bilingual children can be minimized with bilingual programs (Rolstad, Mahoney, & Glass, 2005). In a report by the National Literacy Panel on Language-Minority Children and Youth, August and Shanahan (2006) highlight that bilingual children or ELL should receive direct instruction in the sounds and structures of both languages to maintain and support the acquisition of these important academic skills. Instruction across both languages should continue as children acquire and learn more advanced skills, such as reading comprehension and writing skills.

These findings are important in that it contributes to our understanding of the role of bilingual language experience on children with ASD and their development of academic skills. These findings, however, should be interpreted cautiously due to the small sample size and may not be representative of children with ASD residing in other geographical areas. Additionally, it is unknown whether there are other cognitive, social, or environmental factors that are underlying the potential differences in academic skills in children with ASD with monolingual or bilingual experience. Future research should specifically assess a range of cognitive, social, and environmental factors to better ascertain the significant factors that predict the development and maintenance of academic skills in children with ASD with bilingual language experience. Although the current study group children based on their experience with one or two languages, future studies should characterize and quantify the level of exposure that bilingual children with ASD experience across all settings and whether academic instruction is available in both languages. In conclusion, the preliminary results presented here suggest that at the very least, bilingual exposure does not pose significant risks to children with ASD.

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