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Research Article

Profiles of language and communication abilities in adolescents with fetal alcohol spectrum disorders

Lauren D. Poth[1], Tracy Love[2] and Sarah N. Mattson[1]

[1]Center for Behavioral Teratology and Department of Psychology, San Diego State University, San Diego, CA, USA and [2]School of Speech, Language and Hearing Sciences, San Diego State University, San Diego, CA, USA

Abstract

Objective: Language and communication are largely understudied among youth with fetal alcohol spectrum disorders (FASD). Findings have been mixed, and have generally focused on more severely affected (i.e., children with FAS alone) or younger children. This study aimed to elucidate the profiles of language (i.e., receptive, expressive, general language) and communication (i.e., functional, social) abilities in adolescents with FASD. **Method:** Participants aged 12–17 years with (AE = 31) and without (CON = 29) prenatal alcohol exposure were included. Receptive and expressive language were measured by the Clinical Evaluation of Language Fundamentals – Fifth Edition (CELF-5). Parents or caregivers completed the Children's Communication Checklist – Second Edition as a subjective measure of general language skills. Functional communication was measured by the Student Functional Assessment of Verbal Reasoning and Executive Strategies and parents or caregivers completed the Social Skills Improvement System Rating Scales as a measure of social communication. Multivariate analysis of variance determined the overall profiles of language and communication and whether they differed between groups. **Results:** The AE group performed significantly lower than the CON group on receptive language and parent report of general language while groups did not significantly differ on expressive language. Groups did not significantly differ on functional communication while social communication was significantly lower in the AE group. **Conclusions:** Results of this study provide important information regarding the overall profile of basic language abilities and higher-level communication skills of adolescents with FASD. Ultimately, improving communication skills of youth with FASD may translate to better overall functioning.

Keywords: fetal alcohol syndrome; fetal alcohol spectrum disorders; neurobehavioral disorder associated with prenatal alcohol exposure; prenatal alcohol exposure; language; communication

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Introduction

Extensive research has investigated the impact of prenatal alcohol exposure (PAE) on several domains of neurobehavioral functioning (Mattson, Bernes, & Doyle, 2019; Mattson, Crocker, & Nguyen, 2011; Mattson & Riley, 1998; Riley, Infante, & Warren, 2011). However, investigations into the effects of PAE on language (i.e., receptive and expressive abilities) and communication (i.e., social and functional exchange of information) have been limited despite the clear clinical and functional relevance of such abilities to individuals with fetal alcohol spectrum disorders (FASD). Prevalence estimates of language-related disorders (i.e., expressive language disorder, receptive language disorder, developmental disorder of speech and language) among youth with fetal alcohol syndrome (FAS) alone are significant, ranging from 67.2% to 81.8% (Popova et al., 2016); thus, the likelihood of elevated rates of language-related disorders are likely to extend to youth across the full spectrum of FASD.

Those studies that have been conducted to explore the effects of PAE on language and communication have primarily focused on children with FAS. Studies show delays in language acquisition (Church & Kaltenbach, 1997) as well as verbal learning and memory deficits in children with FAS (Mattson, Riley, Delis, Stern, & Jones, 1996) which can significantly impact overall language development. Additionally, children with FAS perform worse than their chronological age on language tests, making fewer grammatically correct and complete sentences (Akbarian, 1992; Carney & Chermak, 1991). In another study, 80% of participants with FAS showed impairment on one or more measures of speech, language, voice, or fluency (Iosub, Fuchs, Bingol, & Gromisch, 1981). These studies, while useful, were limited in sample size and most did not include controls for comparison.

While few studies have examined language and communication abilities in children with FASD more broadly, some common findings have been shown. Limited studies have shown that PAE disrupts development of language (Mattson & Riley, 1998) and neuroimaging findings suggest that individuals with FASD likely have alterations in brain areas involved with language (Gautam et al., 2015; Sowell et al., 2008; Sowell et al., 2002;

Corresponding author: Sarah N. Mattson, email: sarah.mattson@sdsu.edu

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Treit et al., 2013; Treit et al., 2014). Further, alcohol-exposed children have demonstrated impaired abilities in basic neuropsychological processes that contribute to language, such as attention and executive function (Kodituwakku & Kodituwakku, 2014; Kodituwakku, 2007; Mattson et al., 2011; Riley et al., 2011). Others have shown that children with PAE show deficits in general receptive and expressive language (Akbarian, 1992; Carney & Chermak, 1991; Church, Eldis, Blakley, & Bawle, 1997; Church & Kaltenbach, 1997; Gentry et al., 1998; McGee, Bjorkquist, Riley, & Mattson, 2009; Wyper & Rasmussen, 2011). However, the degree of impairment for both aspects of language is not agreed upon and insufficient data exists to define the range of impairments in FASD. More broadly, studies have shown that children across the spectrum of FASD perform worse on narrative analysis (e.g., grammatical errors, semantic elaboration) as compared to typically developing controls (Thorne, 2017; Thorne et al., 2007). One study found a dissociation in language abilities whereby alcohol-exposed children performed better on tests of receptive than expressive language ability, though this difference did not reach statistical significance (McGee et al., 2009).

Another reason to study language and communication in FASD is the overlap and high rate of co-occurring disorders (e.g., attention deficit/hyperactivity disorder (ADHD), specific learning disorder, oppositional defiant disorder). For example, FASD and ADHD have similar neurobehavioral features and rates of ADHD in FASD are high (Burd et al., 2003; Fryer et al., 2007; Landgren et al., 2010; Mattson et al., 2011; O'Connor & Paley, 2009; Rasmussen et al., 2010). Children with ADHD have more language problems than typically developing controls (Sciberras et al., 2014) and thus, it is reasonable to expect language and communication difficulties in individuals with FASD. Investigating language and communication skills of adolescents with FASD in comparison to a heterogeneous group will help clarify patterns and elucidate findings that may be specific to PAE.

Higher-level communication broadly encompasses the many skills (e.g., language, executive function, attention, perspective taking) necessary for the exchange of information; language is one of these skills. For the purpose of this study, social communication is conceptualized as communication used in social situations or when interacting with others while functional communication is communication used to get one's needs or wants met. In terms of communication and socialization skills, young children with PAE and children with ADHD score lower on measures of adaptive functioning (i.e., socialization, communication, daily living skills) than typically developing controls. However, adolescents with PAE show greater impairment in these abilities than adolescents with ADHD, suggesting an arrest in development of communication and socialization skills in FASD, rather than the delay in development of these abilities seen in ADHD (Crocker et al., 2009; Doyle et al., 2018). Further, children with FASD have social, but dysfunctional, communicative interactions (Akbarian, 1992).

To be successful in communication, one must invoke language skills, social cognition, and executive function skills. As highlighted above, children with FASD show an array of deficits in these areas, but no clear pattern has emerged (Coggins et al., 2007). During adolescence, academic and social demands are increased and difficulties emerge due to the requirement of independent functioning, decreased adult supervision, and increased peer pressure (Streissguth, 1986). Furthermore, social deficits have been shown to persist across the lifespan of individuals with FASD, and may even worsen with age (Kully-Martens, Denys, Treit, Tamana, & Rasmussen, 2012). As previously stated, most studies have either focused on young children with FASD or on individuals with FAS alone. Thus, the adolescent age range is of critical importance for studying language and communication abilities in this population.

Although the aforementioned differences in language and communication have been found, some findings are inconsistent (Flak, Bertrand, Denny, Kesmodel, & Cogswell, 2014). Some prospective studies have found that children with PAE are more likely to be diagnosed with a language delay (Kuehn et al., 2012) while others have found no association between language skills and PAE (Davis, Gagnier, Moore, & Todorow, 2013). Further, Greene and colleagues (Greene, Ernhart, Martier, Sokol, & Ager, 1990) found little association between PAE and language development among alcohol-exposed individuals without FAS. Another study found that children with FASD performed significantly lower on the language composite of one neuropsychological battery (i.e., NEPSY-II), but did not perform worse on measures of receptive and expressive vocabulary (Nash et al., 2013). In contrast, retrospective studies have rather consistently documented language deficits (i.e., grammatical, semantic, pragmatic) among alcohol-exposed youth (Akbarian, 1992; Carney & Chermak, 1991; Crocker et al., 2009; Iosub, Fuchs, Bingol, & Gromisch, 1981).

Given the gap and noted discrepancies in current literature, this study aimed to examine language and communication abilities in adolescents with FASD. To this end, we sought to establish comprehensive profiles of strengths and weaknesses in language (i.e., receptive, expressive) and communication (i.e., social, functional) of adolescents with FASD and compare these profiles to controls. We hypothesized that: (1) adolescents with FASD will display overall impaired language ability as well as impaired performance on selected measures as compared to controls; specifically, adolescents with FASD will display poorer expressive than receptive language ability; and (2) adolescents with FASD will display impaired performance on measures of functional and social communication as compared to controls. Findings will provide clinically valuable information regarding the language and communication abilities in individuals with FASD and inform future development of interventions to improve communication and related functional deficits of adolescents with FASD.

Method

General methods

Participants ($N = 60$) were tested individually during a 2-hour testing session. All participants completed a brief hearing screening with a GSI audiometer for pure tone thresholds (20–30 dB, 1000–4000 Hz) at the start of testing to ensure intact hearing at the level of conversational speech. No participants were excluded due to hearing loss. Parents or caregivers completed questionnaires while the participant underwent testing. Informed consent was obtained from parents or caregivers, and informed assent was obtained from participants. Cognitive data (i.e., full scale IQ) were not collected as part of the current study but were available from concurrent, ongoing studies as part of the Collaborative Initiative on Fetal Alcohol Spectrum Disorders, Phase Four (CIFASD-4) multisite study (Mattson et al., 2010). Financial incentive was provided to caregivers and participants. The Institutional Review Board at San Diego State University approved study procedures. Research was completed in accordance with the Helsinki Declaration.

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Participants

All participants were primary English speakers between the ages of 12:0–17:11. Participants were recruited as part of the CIFASD-4. Full scale IQ (FSIQ) was obtained through the Wechsler Intelligence Scale for Children – Fifth Edition (ages 12:0–16:11) or the Wechsler Abbreviated Scale of Intelligence – Second Edition (ages 17:0+). Adolescents from all ethnicities, races, and sexes were included in the study based on exclusion and inclusion criteria outlined below. Participants were evaluated for the presence of ADHD symptoms using the ADHD Rating Scale – 5 for Children and Adolescents (American Psychiatric Association, 2013; DuPaul, Power, Anastopoulos, & Reid, 2016). Testing was completed over three separate days with one of two examiners. All data was re-checked by one of the evaluators (who had not completed the testing) and a third party to ensure accurate data collection. In addition to neurobehavioral testing, all participants were examined by a dysmorphologist for the presence of FAS based upon CIFASD criteria (Jones et al., 2006; Mattson et al., 2010). Information regarding existing language or speech diagnoses was collected by parent report along with demographic data to determine whether such differences account for group differences in language and communication. In addition, information regarding parental socioeconomic status, including highest level of education and income, was collected.

Participants comprised two groups: PAE (AE; $n = 31$) and controls (CON; $n = 29$). Participants in the AE group had heavy PAE, defined as maternal intake of ≥4 drinks per occasion at least once per week, or >13 drinks per week (Jones et al., 2006; Mattson et al., 2010). Information on maternal alcohol use and other prenatal exposures was obtained through caregiver questionnaires and interview, if available. In cases where direct maternal report was not available, a review of medical, social services, or court records was completed. In these cases, participants were included in the AE group if there was documentation of alcohol abuse or dependence in the biological mother or if exposure was suspected and the child met criteria for FAS. Participants in the CON group were controls with minimal or no PAE and with or without other diagnosed or suspected clinical or behavioral concerns (e.g., ADHD, autism spectrum disorder, oppositionality, depression, anxiety) based on parent report. Minimal exposure is defined as <1 drink per week and never more than 2 drinks per occasion during pregnancy. Further, participants were excluded from the CON group if alcohol exposure information was unavailable or greater than minimal exposure was suspected. Per CIFASD criteria, participants were excluded from the study if they had a medical (e.g., uncorrected hearing or vision loss) or psychiatric illness (e.g., active psychotic episode) that precluded inclusion in the study, or serious head injury with loss of consciousness >30 min (no participants sustained a head injury with loss of consciousness). Individuals with another known cause of mental deficiency (e.g., chromosomal abnormality, neurofibromatosis) were excluded from participation. Information for participants with delayed language was obtained and sub-analyses on those who fall into this subgroup were performed. Demographic information for both groups can be found in Table 1.

Measures

The following measures were selected to obtain a comprehensive profile of language and communication abilities.

Table 1. Demographic information for adolescents with heavy prenatal alcohol exposure (AE) and controls (CON)

Demographic Variable	**AE ($n = 31$)**	**CON ($n = 29$)**
Sex [*n* (% Female)]	16 (51.6)	14 (48.3)
Age [*Mean* (SD)]	14.5 (1.71)	14.6 (1.36)
Race [*n* (% White)]	22 (71.0)	25 (86.2)
Ethnicity [*n* (% Hispanic)]	11 (35.5)	12 (41.4)
Handedness [*n* (% Right)]	30 (96.8)	25 (86.2)
FSIQ [*Mean* (SD)]*	89.6 (15.02)	98.4 (18.97)
Research Diagnosis	–	–
ADHD [*n* (%)]*	24 (77.4)	9 (32.1)
FAS [*n* (%)]*	5 (16.1)	0 (0.0)
Parental Education [*n* (%)]	–	–
Partial High School	0 (0.0)	1 (3.5)
High School Graduate	3 (9.6)	1 (3.5)
Partial College	7 (22.6)	7 (24.1)
Standard College/University	11 (35.5)	11 (37.9)
Graduate/Professional Training	10 (32.3)	9 (31.0)
Family Income [*n* (%)]	–	–
$10,001–20,000	3 (9.7)	2 (6.9)
$20,001–30,000	0 (0.0)	3 (10.3)
$30,001–50,000	2 (6.5)	0 (0.0)
$50,001–75,000	9 (29.0)	2 (6.9)
$75,001–100,000	6 (19.3)	9 (31.0)
$100,000+	11 (35.5)	13 (44.8)
Delayed Speech/Language [*n* (%)]	8 (25.8)	4 (13.8)
Early Intervention [*n* (%)]	5 (62.5)	3 (75.0)
Expressive Language Disorder [*n* (%)]	4 (12.9)	1 (3.4)
Auditory Processing Disorder [*n* (%)]	6 (19.4)	2 (6.9)
Specific Learning Disorder [*n* (%)]	10 (32.3)	8 (27.6)

Note: * $p < .05$ level, ADHD = attention deficit/hyperactivity disorder; FAS = fetal alcohol syndrome. FSIQ, an estimate of general intellectual ability, was measured using the Wechsler Intelligence Scale for Children – Fifth Edition (WISC-V) for participants ages 12:0–16:11 and the Wechsler Abbreviated Scale of Intelligence– Second Edition (WASI-II) for participants ages 17:0+. Research criteria for ADHD was determined using the ADHD Rating Scale – 5 for Children and Adolescents. FAS was determined by presence of two of three key facial features (short palpebral fissures, smooth philtrum, thin vermillion) and either microcephaly or growth deficiency or both. Previous diagnoses (i.e., delayed speech/language, expressive language disorder, auditory processing disorder, specific learning disorder) were based on parent report.

Clinical Evaluation of Language Fundamentals-Fifth Edition (CELF-5; Wiig, Semel, & Secord, 2013)

The CELF-5 is a comprehensive measure to assess language and communication disorders in children and adolescents. The CELF-5 is widely used within school systems and is recognized as a valid measure of language and communication abilities. The CELF-5 was standardized and normed on a sample of more than 4,500 individuals and demonstrates sound psychometric properties. The Receptive and Expressive Language Index standard scores ($M = 100$, SD = 15) were used in analyses with lower scores indicating weaker performance.

Goldman-Fristoe Test of Articulation-Third Edition (GFTA-3; Goldman & Fristoe, 2015)

The GFTA-3, a measure of speech sound and articulation abilities, was used to obtain information regarding participants' speech sound abilities to rule out speech- or articulation-level deficits. The child engages in both spontaneous and imitative sound production to measure the child's speech abilities. The Sounds-in-Words standard score ($M = 100$, SD = 15) was used in analyses with lower scores indicating weaker performance.

Children's Communication Checklist-Second eEdition (CCC-2; Bishop, 2006)

The CCC-2 is a parent- or caregiver-report questionnaire that addresses the child's language (i.e., speech, syntax, semantics,

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and coherence) and communication abilities (i.e., initiation, scripted language, context, nonverbal communication, social relations, and interests). It is sensitive to deficits in language and pragmatic communication. As parent-reported and directly measured abilities often do not align among this population (e.g., Gross, Deling, Wozniak & Boys, 2015; Nguyen et al., 2014; Glass et al., 2014; Rai et al., 2017; Mohamed et al., 2019), inclusion of parent-reported general language abilities provides a comprehensive profile of overall language abilities and allows for examination of direct versus subjective measures. The General Communication Composite standard score ($M = 100$, SD = 15) was used in analyses as a measure of general language abilities. This measure is sensitive to general language deficits, with lower scores indicating weaker performance. Parents of participants over the age of 16:11 ($n = 3$) did not complete this measure due to being out of the normative age range.

Student Functional Assessment of Verbal Reasoning and Executive Strategies (S-FAVRES; MacDonald, 2013)

The S-FAVRES is a measure of higher-order cognitive and communication skills and was employed to objectively determine the functional communication and interaction abilities of these individuals. Beneficially, this measure is sensitive to higher-order language and communication deficits that may emerge during adolescence and has been standardized on language unimpaired and impaired populations. Constructs tapped by the S-FAVRES include verbal reasoning, social communication, planning, problem solving, and meta-cognition. The S-FAVRES provides four composite normative scores across four tasks: Total Accuracy, Total Time, Total Rationale, Total Reasoning Subskills. The Total Reasoning Subskills standard score ($M = 100$, SD = 15) was included in analyses as a measure of functional communication with lower scores indicating weaker performance. This subtest requires participants to answer a series of questions regarding their thought processes in solving four real-world problems. As the test authors highlight, the Total Reasoning Subskills measure provides a means to examine reasoning strengths and weaknesses as it is not possible to understand internal reasoning processes in just evaluating time or accuracy in responding. Thus, it allows for an examination of functional communication skills (e.g., identifying facts, filtering out irrelevant facts, creating responses, thinking flexibly).

Social Skills Improvement System Rating Scales (SSIS; Gresham & Elliott, 2008)

The SSIS is a parent- or caregiver-report questionnaire that assesses problem behaviors and social skills. The SSIS was selected to obtain a subjective report of an individual's social communication and interaction abilities. Social communication requires many skills, including appropriate usage of language, executive function, and social cognition. The Social Skills subscale integrates information important for social functioning and interactions including communication, cooperation, assertion, responsibility, empathy, engagement, and self-control. Thus, the SSIS provides a more complete evaluation of one's social communication abilities above and beyond fundamental language skills alone. The Social Skills standard score ($M = 100$, SD = 15) was included in analyses with lower scores indicating weaker abilities as rated by caregivers.

Statistical analyses

SPSS statistical software v.26 was used for analyses. Demographic data were analyzed with analysis of variance (ANOVA; for continuous variables) or chi-square (for categorical variables) statistical procedures. Multivariate analysis of variance (MANOVA) was used to address the primary hypotheses, as correlations among target dependent variables was expected. Assumptions of homogeneity of variance and covariance were examined with Box's M and Levene's test statistics with an alpha level of .001 used to evaluate homogeneity assumptions. An alpha level of .05 was used to determine statistical significance for other analyses and effect sizes were consulted to determine practical significance.

First, a MANOVA with group (AE, CON) as the between-subjects variable and language domain (Receptive, Expressive, Speech Sound, General Language) as the within-subject variable was conducted to determine the overall profile of language ability of adolescents with FASD and how this profile differs from controls. Paired samples t-tests investigated the relationship between receptive and expressive language abilities within each group. Next, a MANOVA with group (AE, CON) as the between-subjects factor and social/functional communication (SSIS, S-FAVRES) as the correlated outcome was conducted to examine differences in communication between AE and CON. Group differences on all neuropsychological variables were tested using independent samples t-tests.

Table 2. Group performance on neuropsychological variables

Neuropsychological Variable [*Mean* (SD)]	AE ($n = 31$)	CON ($n = 29$)
LANGUAGE	–	–
Receptive Language (CELF-5)*	87.8 (12.68)	96.5 (17.41)
Expressive Language (CELF-5)	90.3 (13.99)	96.2 (16.47)
Language Impairment (*n* [%])	11 (38%)	10 (35%)
Speech Sound (GFTA-3)	102.0 (3.97)	103.0 (0.78)
Communication (S-FAVRES)	79.0 (14.58)	85.8 (21.15)
PARENT REPORT	–	–
General Language (CCC-2)*	79.0 (22.62)	98.7 (19.67)
SIDI (CCC-2)	−6.5 (8.32)	−1.6 (7.43)
Social Communication (SSIS)*	77.1 (18.68)	92.4 (19.95)

Note: Groups included adolescents with heavy prenatal alcohol exposure (AE) and controls (CON). * $p < .05$ level, CELF-5 = Clinical Evaluation of Language Fundamentals – Fifth Edition; GFTA-3 = Goldman-Fristoe Test of Articulation – Third Edition Sounds-In-Speech; S-FAVRES = Student Functional Assessment of Verbal Reasoning and Executive Strategies Total Reasoning Subskills; CCC-2 = Children's Communication Checklist – Second Edition General Communication Scale; SIDI = Social Interaction Difference Index (SIDI) from the CCC-2; SSIS = Social Skills Improvement System Rating Scales Social Skills Scale; All variables were measured using standard scores. The SIDI is calculated from scaled scores on the CCC-2 with positive scores indicating greater non-pragmatic language impairment and negative scores indicating greater pragmatic and social impairments (scores between −10 and 10 are within the normative range). Number of participants with language impairment was determined by CELF-5 Core Language Index ≤ 1 SD below the mean or 2 or more core subtests ≤ 1 SD below the mean (Leonard, 1998).

Results

Demographic data

Groups did not significantly differ on handedness ($p = .139$), sex ($p = .796$), ethnicity ($p = .135$), race ($p = .152$), or age ($p = .814$). As expected, groups significantly differed on FSIQ ($p = .049$) and presence of ADHD ($p < .001$). Specifically, the AE group ($M = 89.5$; SD = 15.02) had significantly lower FSIQ scores than the CON group ($M = 98.4$; SD = 18.97) and had a significantly higher proportion of participants that met research criteria for ADHD ($n = 24$; 77%) than the CON group ($n = 9$; 32%). Due to statistical and methodological limitations discussed elsewhere (Dennis et al., 2009), FSIQ was not considered as a covariate in subsequent analyses. However, correlation analyses conducted within each group revealed that FSIQ significantly correlated with expressive and receptive language ($ps \le .001$) in both groups. Group performance on all variables is presented in Table 2. Separate

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Table 3. Correlations among MANOVA-dependent variables for separate language and communication analyses, respectively

Measure	1	2	3	4
1. Receptive Language	–			
2. Expressive Language	.737*	–		
3. Speech Sound	.123	.212	–	
4. General Language	.576*	.635*	.199	–
1. Social Communication	–			
2. Functional Communication	.530*	–		

Note: * $p < .001$ level. Receptive and Expressive Language were measured by the Clinical Evaluation of Language Fundamentals – Fifth Edition. Speech Sound abilities were measured by the Goldman-Fristoe Test of Articulation – Third Edition Sounds-In-Speech subtest. General Language was measured by parent report from the Children's Communication Checklist – Second Edition General Communication Scale. Social Communication was measured by the Social Skills Improvement System Rating Scales Social Skills Scale. Functional Communication was measured by the Student Functional Assessment of Verbal Reasoning and Executive Strategies Total Reasoning Subskills.

Table 4. MANOVA results for language profile by group

Language Variable	Group [F (df)]	*p*	Partial η^2
Omnibus*	3.135 (4, 48)	.023	.207
Receptive Language*	6.117 (1, 51)	.017	.107
Expressive Language	2.831 (1, 51)	.099	.053
Speech Sound	1.386 (1, 51)	.245	.026
General Language*	10.365 (1, 51)	.002	.169

Note: Groups included adolescents with heavy prenatal alcohol exposure (AE) and controls (CON). * $p < .05$ level, df = degrees of freedom. Standard scores from each measure were included in analyses. Receptive Language and Expressive Language were measured by the Clinical Evaluation of Language Fundamentals – Fifth Edition. Speech Sound abilities were measured by the Sounds-In-Words subtest from Goldman-Fristoe Test of Articulation – Third Edition. General Language was measured by parent report from the General Communication Scale from the Children's Communication Checklist – Second Edition.

correlation analyses for measures used in the language MANOVA and communication MANOVA are presented in Table 3.

Groups did not significantly differ on number of participants with delayed speech and language acquisition ($p = .245$). Of those participants with delayed speech and language acquisition, groups did not significantly differ on participants that received early intervention services ($p = .665$). In addition, groups did not significantly differ on number of participants with existing expressive language disorder ($p = .185$), auditory processing disorder ($p = .156$), or specific learning disorder ($p = .693$) diagnoses based on parent report. Groups also did not significantly differ on parental education ($p = .738$) or family income ($p = .066$). As such, these variables were not considered in the following analyses.

Language and communication data

A MANOVA with group (AE, CON) as the between-subjects variable and domain (Receptive, Expressive, Speech Sound, General Language) as the within-subject variable was conducted to determine the overall profile of language ability of adolescents with FASD and how this profile differs from controls. Results are presented in Table 4. Box's M test of homogeneity of covariance ($p < .001$) was statistically significant and Levene's homogeneity test (all *ps* > .026) was not statistically significant. Using Wilk's criterion (Λ) as the omnibus test statistic, the combined dependent variables resulted in a significant main effect of group [$F(4, 48) = 3.135$, $p = .023$, partial $\eta^2 = .207$].

To probe the statistically significant multivariate effects, univariate ANOVAs were conducted on each individual dependent variable (Receptive, Expressive, Speech Sound, General Language). Overall, the AE group performed below the CON group on all measures and significantly differed from the CON group on receptive language and parent-reported general language abilities (see Figure 1). Expressive and receptive language scores were not significantly different within the AE group ($t(29) = -1.469$, $p = .153$) or the CON group ($t(28) = .146$, $p = .885$). For receptive language, there was a significant main effect for group [$F(1, 51) = 6.117$, $p = .017$, partial $\eta^2 = .107$] and receptive language scores were significantly higher for the CON group ($M = 96.5$) relative to the AE group ($M = 87.8$). For parent report of general language, there was a significant main effect for group [$F(1, 51) = 10.365$, $p = .002$, partial $\eta^2 = .169$]. Parents rated the general language skills of the CON group ($M = 98.7$) higher relative to the AE group ($M = 79.0$). The main effect for group was not statistically significant for expressive language [$F(1, 51) = 2.831$, $p = .099$, partial $\eta^2 = .053$] or speech sound abilities [$F(1, 51) = 1.386$, $p = .245$, partial $\eta^2 = .026$].

A MANOVA with group (AE, CON) as the between-subjects factor and social/functional communication (SSIS, S-FAVRES) as the correlated outcome was conducted to examine differences in communication between AE and CON. Results are presented in Table 5. Box's M test of homogeneity of covariance ($p = .213$) and Levene's homogeneity test (all *ps* > .025) were not statistically significant. Using Wilk's criterion (Λ) as the omnibus test statistic, the combined dependent variables resulted in a significant main effect for group [$F(2, 54) = 4.5000$, $p = .016$, partial $\eta^2 = .143$].

To probe the statistically significant multivariate effects, univariate ANOVAs were conducted on each individual dependent variable (SSIS, S-FAVRES). Overall, groups did not differ on functional communication performance [$F(1, 55) = 2.374$, $p = .129$, partial $\eta^2 = .041$], but parents rated the social communication abilities of the AE group as significantly worse than the CON group [$F(1, 55) = 9.167$, $p = .004$, partial $\eta^2 = .143$] (see Figure 2). Parents rated the CON group ($M = 92.4$) as having significantly higher (i.e., stronger) social communication abilities relative to the AE group ($M = 77.1$).

Post hoc analyses

Follow-up analyses examined whether inclusion of a heterogeneous CON group influenced results, specifically the contribution of ADHD to results. Participants within the CON group that met research criteria for ADHD ($n = 9$) were excluded and analyses were re-examined. Results for the language MANOVA remained except the group difference in expressive language became significant [$F(1, 44) = 5.140$, $p = .028$, partial $\eta^2 = .105$]. Expressive language scores were significantly higher (i.e., stronger) for the CON group ($M = 100.2$) relative to the AE group ($M = 90.3$). Results for the communication MANOVA remained except the group difference in functional communication became significant [$F(1, 47) = 4.864$, $p = .032$, partial $\eta^2 = .094$]. Functional communication scores were significantly higher (i.e., stronger) for the CON group ($M = 89.9$) relative to the AE group ($M = 79.0$).

Discussion

Overall, this study aimed to identify the profiles of language (receptive, expressive, speech sound abilities, general language) and communication (functional, social) abilities among adolescents with heavy PAE and how these abilities differ from controls. In terms of language abilities, our hypotheses were partially supported as

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Table 5. MANOVA results for communication profile by group

Communication Variable	Group [F (df)]	*p*	Partial η^2
Omnibus*	4.500 (2, 54)	.016	.143
Social Communication*	9.167 (1, 55)	.004	.143
Functional Communication	2.374 (1, 55)	.129	.041

Note: Groups included adolescents with heavy prenatal alcohol exposure (AE) and controls (CON). * $p < .05$ level, df = degrees of freedom. Social Communication was measured by the Social Skills standard score from the Social Skills Improvement System Rating Scales completed by parents. Functional Communication was measured by the Total Reasoning Subskills standard score from the Student Functional Assessment of Verbal Reasoning and Executive Strategies test.

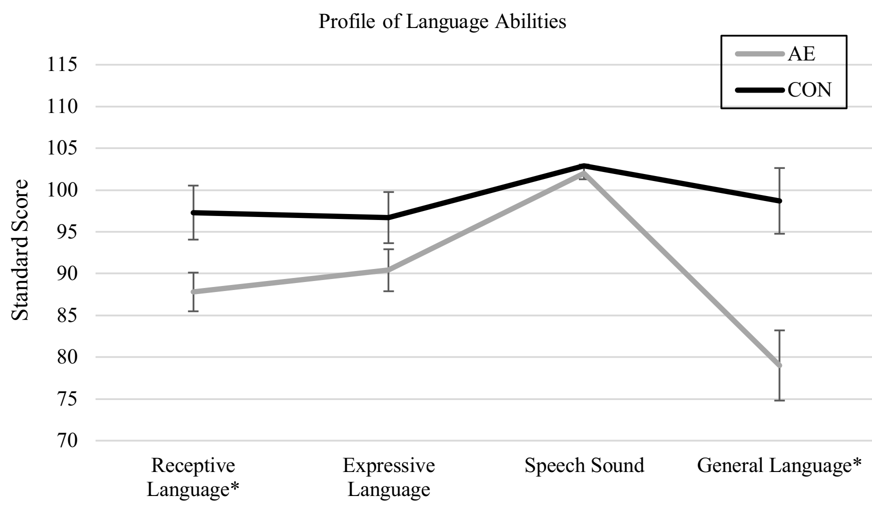

Figure 1. Profile of language abilities by group. Groups included adolescents with heavy prenatal alcohol exposure (AE) and controls (CON). Groups significantly differed on receptive language and parent report of general language.
Note: * $p < .05$ level. Receptive Language and Expressive Language were measured the Clinical Evaluation of Language Fundamentals – Fifth Edition. Speech Sound abilities were measured by the Sounds-In-Words subtest from Goldman-Fristoe Test of Articulation – Third Edition. General Language was measured by parent report from the General Communication Scale from the Children's Communication Checklist – Second Edition.

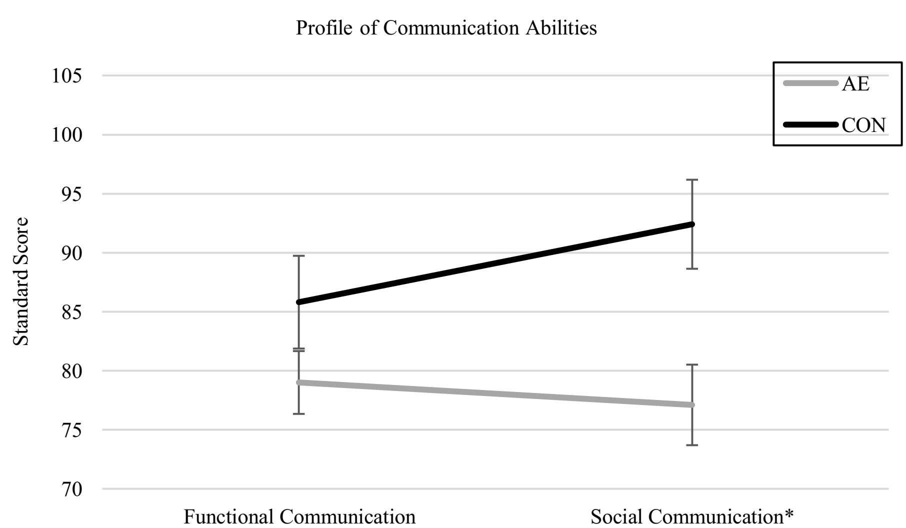

Figure 2. Profile of communication abilities by group. Groups included adolescents with heavy prenatal alcohol exposure (AE) and controls (CON). Groups significantly differed in social communication.
Note: * $p < .05$ level. Groups significantly differed on social communication. Functional Communication was measured by the Total Reasoning Subskills standard score from the Student Functional Assessment of Verbal Reasoning and Executive Strategies test. Social Communication was measured by the Social Skills standard score from the Social Skills Improvement System Rating Scales completed by parents.

the AE group performed below the CON group on all measures examined (Receptive Language, Expressive Language, Speech Sound, General Language) although these differences were only statistically significant on receptive language and parent report of general language. Furthermore, receptive language did not significantly differ from expressive language abilities within either group. These findings differ from previous studies that showed significant differences in both receptive and expressive language

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between alcohol-exposed participants and controls as well as stronger receptive than expressive language skills (Akbarian, 1992; Carney & Chermak, 1991; Church et. al, 1997; Church & Kaltenbach, 1997; Gentry et al., 1998; McGee et al., 2009; Wyper & Rasmussen, 2011).

The patterns of language performance in previous studies and the current study suggest interesting developmental trends although longitudinal studies are needed to confirm cross-sectional observations. The lack of group differences on expressive language in the current study may be attributable to the inclusion of a heterogeneous comparison group as follow-up analyses showed that in removing the CON participants who met research criteria for ADHD, groups significantly differed on expressive language abilities as well, though there were still no within-group differences between expressive and receptive language. That is, differences in expressive language abilities between groups may be attributed to factors other than PAE. Furthermore, the current study investigated these abilities among adolescents whereas previous studies have focused on younger children (e.g., 3–9 years of age) with PAE. Longitudinal studies among non-exposed individuals with developmental language disorders show a pattern of impaired but stable language abilities over time (Johnson et al., 1999) although certain skills appear to plateau as individuals continue to fall behind as compared to their peers (Stothard et al., 1998). Taken together, results from the current study and those from previous studies highlight the need for longitudinal studies among individuals with PAE to clarify the developmental trajectories of these important language skills to help clarify noted inconsistencies in younger children with FASD.

In addition to the differences in statistical significance, examination of effect sizes (see Table 4) suggests that receptive language (partial $\eta^2 = .107$) is more strongly related to group membership than expressive language (partial $\eta^2 = .053$) highlighting the importance of receptive language abilities among adolescents with PAE. Notably, the prognosis for receptive language disorder is worse than that for expressive language disorder and early and ongoing intervention is key in addressing these difficulties (Clark et al., 2007). Results demonstrate that language and communication difficulties remain in adolescence suggesting that individuals with PAE do not "grow out" of these deficits. In addition, individuals with a pure language disorder in the absence of speech or articulation impairments are at a high risk of developing psychiatric illness (Prizant et al., 1990) likely due to these underlying difficulties not being identified or intervened upon. Findings from the current study show intact speech sound abilities among adolescents with PAE highlighting the risk of these individuals developing psychiatric or functional issues due to underlying language disorders and potential for these language disorders to go unidentified.

The clinical implications of language disorders are clear. Language disorders can impact long-term functioning in terms of academic functioning, occupational functioning, and socialization skills (American Psychiatric Association, 2013). Among individuals without a history of PAE, early language disorders predict significant social maladaptation in later life as well as increased risk for psychiatric disorders (Clegg et al., 2005). Current results highlight the importance of early identification of language difficulties among youth with PAE to provide intervention as early as possible to improve deficits still evident in adolescence. Future research will necessarily benefit from focusing on the long-term implications for mental health among adolescents with FASD and to what extent language and communication deficits contribute to poor mental health outcomes later in life.

Given the implications for impaired receptive language, findings suggest interventions targeted at improving receptive language abilities may be most beneficial in ameliorating language deficits among youth with PAE given the statistical significance and effect size of receptive language on group membership. Among other neurodevelopmental disorders, limited research has investigated the responsiveness of language disorders to targeted intervention and findings suggest minimal improvement in receptive language abilities although earlier and longer term (i.e., more than 8 weeks) therapy provided better clinical outcomes (Law, Garrett, & Nye, 2004). As such, current results highlight the importance of early identification of language difficulties among youth with PAE to provide intervention as early as possible to improve deficits still evident in adolescence. It will be important to elucidate the underlying cognitive factors (e.g., working memory, attention) that contribute to observed receptive language difficulties to allow for targeted intervention and inform appropriate treatment.

Regarding communication abilities, our hypotheses were once again partially supported as groups did not significantly differ on a direct measure of functional communication (the S-FAVRES) but did significantly differ on a measure of social communication (SSIS). However, the average functional communication score of the AE group fell more than one standard deviation below average ($M = 79.0$) while the CON group was within the low end of the average range ($M = 85.8$) and parents of exposed youth reported difficulties in social communication on the SSIS. In addition, follow-up analyses that removed CON participants meeting research criteria for ADHD lead to an increase in functional communication scores in the CON group ($M = 89.9$) and the difference between functional communication scores of the AE and CON groups becoming significant. The current study may have been underpowered to detect a statistically significant difference in functional communication with a heterogeneous control group though findings may suggest other explanatory factors are contributing to communication differences. Indeed, it is important to acknowledge the widespread impact ADHD can have on other cognitive skills, such as executive function, that may be impacting on functional communication. However, follow-up analyses highlight the significant impairment in communication among adolescents with PAE. Importantly, the S-FAVRES was designed to discriminate typical or average performance from below average performance. Based on descriptors provided by test manufacturers, the AE group performed in the below average range while the CON group performed in the low average range (MacDonald, 2013) highlighting the clinical significance of communication difficulties among the AE group. Social and functional communication abilities of the AE group were generally comparable and did not significantly differ.

Limitations/future directions

Findings from the present study should be considered within the context of several limitations. First of all, while several interesting results were shown, we were limited in our sample size which may have restricted statistically significant results. As such, we may have not had adequate statistical power to detect relations with smaller effect sizes. Given observed effect sizes ranging from $.041 <$ partial $\eta^2 < .169$ for MANOVA, post hoc power analyses showed required sample sizes ranging from 69 to 270 in order to detect significant special effects of interest. Despite this limitation, several significant results were revealed, and effect size

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estimates provide additional information for potentially significant findings. Similarly, we were limited in the adolescent age range we were able to investigate (i.e., 12–17 years) based on normative age ranges for the chosen measures. Future studies should expand upon this age range and consider longitudinal examination to elucidate developmental trajectories of language and communication abilities.

Other possible limitations include the assessments chosen to measure study constructs. For example, the S-FAVRES was included as an objective measure of functional communication. While standardized on language impaired (i.e., adolescents with traumatic brain injury) and unimpaired participants (MacDonald, 2013), it may be more sensitive to attention difficulties and effort as group differences were not evident with a heterogeneous control group. Despite these limitations, the AE group performed below the average range while the CON group was within the average range, particularly when removing participants meeting research criteria for ADHD. As highlighted above, the purpose of the S-FAVRES is to identify individuals with below average communication skills and results suggest possible use in clinical settings to delineate cognitive-communication difficulties experienced by adolescents with PAE. Nevertheless, future studies with larger sample sizes will help clarify this pattern. Concern may also exist in using parent-report questionnaires as parents or caregivers may be similarly impaired in language abilities. A reading level roughly equivalent to the fifth grade is required for parent-report questionnaires (Bishop, 2006; Gresham & Elliott, 2008) and follow-up analyses showed that caregiver education level did not significantly predict CCC-2 or SSIS scores ($ps \geq .139$). Therefore, it is unlikely that caregiver education levels significantly influenced results. However, inclusion of a direct measure of social communication may be helpful to clarify or validate parent-reported concerns. Along those lines, it is important to note that the AE group demonstrated comparable parental education and income to the control group suggesting that these individuals may not be experiencing psychosocial difficulties often noted in FASD. As such, adolescents with greater clinical complexities may demonstrate even more difficulties than current findings suggest.

Additional confounds that are inherent to PAE should be considered. Other psychiatric disorders are highly prevalent among individuals with PAE and may have contributed to our findings (e.g., ADHD, depression). Nonetheless, inclusion of a heterogeneous control group provides additional support for our findings above and beyond comorbid diagnoses. We also considered the contribution of autism spectrum disorder (ASD) to our findings as the AE group had significantly more ($p = .004$) participants with an existing ASD diagnosis ($n = 10$; 32.3%) than the CON group ($n = 1$; 3.4%) per parent report. However, we did not specifically recruit participants with an ASD diagnosis and did not verify the accuracy of the diagnosis. Exploratory analyses showed that within the AE group, participants with and without an existing ASD diagnosis, based on parent report, did not significantly differ on any language or communication variables ($ps \geq .087$) from the larger group. Future studies should consider inclusion of an ASD comparison group to investigate these relations between language and communication and clarify the profile of abilities between youth with FASD and those with ASD. In addition, information regarding ongoing medication usage was not available, though all participants were asked to refrain from medication usage on the days of testing. However, potential cumulative effects due to medication usage cannot be excluded.

Other confounds include maternal use of other substances (e.g., cocaine, nicotine, marijuana) during pregnancy. Due to the retrospective nature of this study, specific information regarding smoking or other drug use is unknown and as such we cannot account for these potentially confounding variables. We require evidence of alcohol as the primary substance of exposure for inclusion in the alcohol-exposed group, though we cannot rule out the effects of other drugs of abuse. Future studies would benefit from investigating the potential contribution of other substances to patterns of language and communication impairment among these youth. Finally, differences may be explained by overall performance differences (e.g., IQ) between groups as the AE group performed below the CON group on most measures though the average FSIQ score for both groups fell in the average range. Given methodological and statistical limitations, we did not test FSIQ as a covariate (Dennis et al., 2009). Other studies have suggested that IQ does not fully account for communication deficits among alcohol-exposed individuals (Doyle et al., 2019), although other aspects of cognitive functioning not included in the current study may play an important role in mediating the relation between PAE, language, and communication.

Conclusions

The current study is the first known comprehensive investigation of language and communication abilities of adolescents with PAE. In terms of language, the alcohol-exposed group performed below the control group on all variables though only significantly differed in receptive language skills and parent report of general language. These findings have significant clinical implications as receptive language disorders are often difficult to identify and treat. While adolescents with PAE did not differ from heterogeneous controls on a measure of functional communication, the average scores of the alcohol-exposed group fell in the below average range identifying these participants as experiencing clinically significant communication difficulties. Furthermore, parents of adolescents with PAE reported significantly impaired social communication skills as compared to controls. The clinical implications of language and communication difficulties are clear. As highlighted above, intact speech sound abilities among this population increases the risk for long-term functional impairment in the presence of underlying language and communication disorders due to lack of identification (Prizant et al., 1990). Results again highlight the need for early identification in combination with integrated and multidisciplinary treatment to improve academic, social, and overall wellbeing of youth with PAE.

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Conflict of interest. None.

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