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14. ABSTRACT
The purpose of this RCT is to test the efficacy of an outpatient psychosocial treatment (MAXout) on the ASD symptoms and social-communicative functioning of 7-12 year olds with HFASD. The treatment targets social/social-communication skills, non-literal language skills, emotion-decoding skills, and interest expansion. Treatment is delivered over 18 weeks (two 90 min. sessions/wk.) with each treatment group consisting of 4 children with HFASD and 2 staff clinicians. Efficacy is assessed immediately following the 18-week treatment and 4-6 weeks post-treatment. Following year 4, significant progress has been made in regard to Major Task 1 (RCT) objectives which included completion of the following: (1) closure of IRB protocol and completion of the regulatory review; (2) implementation of the treatment for sampling wave 6; (3) completion of pretest, posttest, and follow-up measures for sampling wave 6; (4) recruitment and training of staff clinicians and research assistants for waitlist controls (sampling wave 6); and (5) implementation of the treatment for waitlist controls (sampling wave 6). Progress has also been made for Major Task 2 (Data Analysis); however the time consuming nature of the coding of the videotaped social interactions hindered completion of the 3 subtasks: subtask 1 – data compilation/quality check; subtask 2 – data analyses; and subtask 3 – dissemination; all are underway and ongoing. These will be completed during the approved Extension without Funds period.

15. SUBJECT TERMS
High-functioning children with ASD, outpatient treatment, comprehensive psychosocial treatment, MAXout, group-based treatment

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1. INTRODUCTION

This RCT is testing the efficacy of an outpatient comprehensive psychosocial treatment (MAXout) on the ASD symptoms and social-communicative functioning of 7-12 year olds with HFASD. The manualized treatment targets social/social-communication skills, interpretation of non-literal language skills, emotion-decoding skills, and interest expansion. Treatment is delivered over 18 weeks (two 90 min. sessions/wk.) with each treatment group consisting of 4 children with HFASD and 2 staff clinicians. The protocol utilizes direct instruction, modeling, role-play (rehearsal), performance feedback (reinforcement), transfer of learning, and repeated practice to foster skills acquisition and maintenance and reduce ASD symptoms. Treatment efficacy is assessed immediately following the 18-week treatment and 4-6 weeks post-treatment.

2. KEYWORDS

High-functioning children with ASD, outpatient treatment, comprehensive psychosocial treatment, MAXout, group-based treatment

3. ACCOMPLISHMENTS

Major goals of the project

Per the approved SOW, this single-site RCT is being conducted to evaluate the efficacy of the innovative outpatient comprehensive psychosocial treatment (MAXout) on the ASD symptoms and social-communicative functioning of 7-12 year olds with HFASD compared to control (waitlist) children with HFASD.

Accomplishments under the goals

Per the SOW, the year 4 objectives were from Major Task 1: Randomized Controlled Trial and Major Task 2: Data Analysis. For Major Task 1, the objectives included the following: (1) closure of IRB protocol and completion of the regulatory review; (2) implementation of the treatment for sampling wave 6; (3) completion of pretest, posttest, and follow-up measures for sampling wave 6; (4) recruitment and training of staff clinicians and research assistants for waitlist controls (sampling wave 6); and (5) implementation of the treatment for waitlist controls (sampling wave 6). For Major Task 2, the objectives included the following: (1) completion of the data compilation and quality check; (2) completion of the data analyses; and (3) dissemination of the findings. The following is a description of progress per each of the objectives.

Closure of IRB protocol and completion of the regulatory review

The Completed Project Study Report and Closure Notice was submitted to the local IRB prior to the expiration date of the project. The local IRB completed its review and closed the study protocol. The approved closure letter and the Completed Project Study Report and Closure Notice were provided to the HRPO on July 22, 2019 with a request for the HRPO to also close the protocol. The HRPO subsequently closed the IRB protocol (email from S.G. Mancha-Wright dated July 30, 2019). **Per the SOW, the IRB protocols and regulatory reviews were completed as proposed.**

Implementation of the treatment for sampling wave 6

As proposed, the children with HFASD randomly assigned to the treatment group completed the 18-week treatment protocol. The treatment groups consisted of 4 children with HFASD and 2 staff clinicians. Treatment was delivered during two 90-minute sessions per week, with each 90-minute session consisting of two 45-minute treatment cycles. Each treatment cycle included 15-minutes of skills instruction followed by a 30-minute therapeutic activity designed to practice the skills learned in the skills instruction. The treatment cycles targeted social/social-communication skills, facial emotion recognition skills, non-literal language skills, and interest expansion using direct instruction, modeling, role-play/rehearsal, performance feedback/reinforcement, and transfer of learning. A structured response-cost point system and individualized daily note (IDN) were also used to promote and strengthen skills acquisition and maintenance and reduce ASD symptoms and problem behaviors. Response-cost and IDN feedback were provided throughout the sessions by the staff clinicians and each child could earn an on-site reward, as well as a reinforcer at home for reaching an individualized target level of performance.

Fidelity was monitored during randomly selected sessions by research assistants uninvolved with treatment delivery, through one-way-mirrored observation rooms; fidelity was 95% for skills groups and 96% for the therapeutic activities. Information was also collected from parents of children on the waitlist during the period that the treatment children were receiving treatment (parent reported support services/therapeutic programming, traumatic events, and medication status/changes). **Per the SOW, the treatment protocol for sampling wave 6 was implemented and completed.**

Completion of pretest, posttest, and follow-up measures for sampling wave 6

Pretest, posttest, and follow-up measures were completed for the children that completed wave 6. One child from the control group completed pretesting but withdrew from the study and did not complete posttest or follow-up. One child from the control group did not complete the direct child testing or videotaped social interactions at follow-up due to physical aggression (but parent ratings were obtained). **Per the SOW, the pretest, posttest, and follow-up measures were completed for sampling wave 6.**

Recruitment and training of staff clinicians and research assistants for waitlist controls (sampling wave 6)

As proposed, 1 clinical supervisor was recruited, 4 staff clinicians were recruited and trained to implement the protocol, and 1 research assistant was recruited to assess fidelity and support data processing. Each of the staff clinicians passed a written exam testing her/his mastery of the treatment manual (score of 100% required), completed the training, and

demonstrated ≥ 90% accuracy (fidelity) administering the protocol prior to initiation of treatment. In addition to assisting with data management, the research assistant was trained in the use of the standardized fidelity forms and required to demonstrate > 90% reliability (inter-observer agreement [IOA]) using the fidelity forms prior to conducting fidelity observations as part of the study. Lastly, 2 behavioral coders were recruited to code the video-recordings of the children's interactions. Each was required to establish IOA prior to the initiation of actual coding and each remained naïve to the treatment condition of the children in the recordings. **Per the SOW, the recruitment and training of staff clinicians and research assistants for waitlist controls (sampling wave 6) was completed as proposed.**

Implementation of the treatment for waitlist controls (sampling wave 6)

As proposed, children with HFASD randomly assigned to the waitlist control completed the 18-week treatment protocol. The groups consisted of 4 children with HFASD and 2 staff clinicians. Treatment was delivered during two 90-minute sessions per week, with each 90-minute session consisting of two 45-minute treatment cycles. Each cycle included 15-minutes of skills instruction followed by a 30-minute therapeutic activity designed to practice the skills learned in the skills instruction. The treatment cycles targeted social/social-communication skills, facial emotion recognition skills, non-literal language skills, and interest expansion using direct instruction, modeling, role-play/rehearsal, performance feedback/reinforcement, and transfer of learning. A structured response-cost point system and individualized daily note (IDN) were also used to promote and strengthen skills acquisition and maintenance and reduce ASD symptoms and problem behaviors. Response-cost and IDN feedback were provided throughout the sessions by the staff clinicians and each child could earn an on-site reward, as well as a reinforcer at home for reaching an individualized target level of performance. **Per the SOW, the treatment protocol for waitlist controls (sampling wave 6) was implemented and completed.**

Completion of the data compilation and quality check

This objective was based on the complete scoring of all measures, data compilation, and quality check for accuracy. This objective is ongoing due to the time consuming nature of coding the videotapes of the children's social behaviors (outcome measure) which took longer than anticipated. We have completed the scoring of the measures and coding of videotapes, and entered the data. We are currently working to complete the data quality check, which will allow for initiation of the data analyses. This was described in our Extension without Funds request that was approved; we will complete this objective in the next 2-4 weeks.

Completion of the data analyses

As indicated in the previous section, the data analyses will be initiated in the next 2-4 weeks, once the data quality check is complete. The study statistician will conduct the analyses and share the findings with the study investigators. The results will be used to develop manuscripts and presentations to disseminate the findings. This was described in our Extension without Funds request that was approved.

Dissemination of the findings

Most dissemination activities will be initiated once the analyses are completed. We anticipate that the analyses will be completed within 2 weeks of their initiation and the findings will be used for preparation of manuscripts and presentations. In addition to manuscripts and presentations, we have already begun finalization of the treatment manual for dissemination, as well as creation of a comprehensive set of training videos that accompany the manual. Lastly, we will initiate discussions with publishers in an effort to identify potential avenues to distribute the treatment manual and training videos and we will complete submission of the final data to the NDAR. These dissemination activities were described in our Extension without Funds request that was approved.

Opportunities for training and professional development provided by project

Although this project is not intended to provide training and professional development opportunities, a number of opportunities are inherent in the project activities including the enhancement of knowledge, skills, and proficiency of undergraduate and graduate students, as well as parents of children with HFASD participating in the trial. These opportunities were afforded to these individuals as a function of their involvement in the evaluation of the outpatient treatment (MAXout) (e.g., intervention implementation, fidelity monitoring, assessment, data management, parent training).

In this study, undergraduate and graduate students serve as staff clinicians (delivering the manualized treatment), research assistants, behavioral coders, and research clinician supervisors. These students receive extensive training in autism spectrum disorder/HFASD, the current state of treatments for HFASD, the empirical basis of the MAXout framework, administration of the MAXout protocol, and effective fidelity monitoring. Depending on their position/role, they spend considerable time prior to the intervention practicing and demonstrating proficiency ($\geq$ 90% fidelity) implementing all components of the treatment, or establishing IOA measuring fidelity or coding behaviors. The undergraduate and graduate students also receive training in the administration and scoring of several outcome measures, as well as in data management and monitoring of data accuracy. Lastly, parents of children with HFASD in the active treatment condition participate in parent training. These parent training sessions educate parents on the components of the program, and strategies for reducing ASD symptoms and promoting skills and generalization. All of these training opportunities were provided and/or supported by the study coordinator, developers of the MAXout protocol, and/or data manager.

Dissemination of results to communities of interest

Nothing to report involving dissemination of results (i.e., outcomes). Outreach activities were undertaken mainly to share information about the project with clinical practitioners and school administrators/staff who would not ordinarily be aware of such research activities. Sharing information about the project has increased public knowledge of the project, as well as assisted with recruitment of participants.

Plans for accomplishing project goals in next reporting period

For the next reporting period, we will be working on the objectives (subtasks) according to the approved Extension without Funds plan. As previously noted, the time consuming nature of the coding of the videotaped social interactions hindered completion of the Major Task 2 (Data Analysis) objectives that included 3 subtasks (i.e., subtask 1 – data compilation/quality check; subtask 2 – data analyses; and subtask 3 – dissemination). The videotapes have been coded and we are currently conducting the final data quality check; we will then initiate the data analyses. As such, we anticipate completing the data quality check and will be conducting the data analyses during the next reporting period. Regarding subtask 3 (dissemination), we have begun finalization of the treatment manual for dissemination and creation of a comprehensive set of training videos that accompany the manual; this subtask will be ongoing during the next and subsequent reporting periods. Once the data analyses are completed, we will generate manuscripts and presentations; this subtask will be accomplished during subsequent reporting periods.

4. IMPACT

Impact of the project on development of the principal discipline(s)

Nothing to report at this point on treatment efficacy. The study is evaluating the efficacy of a comprehensive outpatient psychosocial treatment (MAXout) for children with HFASD. At present, little is known about how to effectively and robustly increase the social and communication skills, and reduce the ASD symptoms of these children in an outpatient format. This subgroup of children with ASD has received limited treatment research attention and their impairments pose a significant challenge to clinical and educational professionals, and parents. Findings from this study will likely impact the fields of psychology and psychiatry. Empirical support for the MAXout program will provide clinical professionals with a clearly-defined and manualized treatment protocol (instructional techniques, content, and progress monitoring measures) for use in clinical outpatient settings. In addition, the comprehensive intervention in this study (MAXout) is an adaptation of other evidence-based psychosocial treatments for children with HFASD that are delivered in a summer program (summerMAX) or school (schoolMAX) format. Support for the MAXout, summerMAX, and schoolMAX programs will allow flexibility in the manner in which public resources may be directed or the delivery format of the critical elements in the programs (outpatient, summer, or school program delivery).

Impact on other disciplines. Nothing to report

Impact on technology transfer. Nothing to report

Impact on society beyond science and technology

No conclusions on efficacy are yet available; however, preliminary results (from the pilot study) suggested positive effects of the treatment on several targeted areas (e.g., social-communication skills, ASD symptoms, etc.). Although final results are not yet available, support for the MAXout treatment protocol may impact the social conditions and outcomes for individuals with HFASD. Findings of other studies have indicated that individuals with HFASD experience long-term challenges that limit their independence and ability to maintain employment, leading to prolonged dependence on family members and societal resources. Improving the social-communication skills and ASD symptoms of children with HFASD may impact future adaptive functioning, and allow career- and vocational-development programs to yield greater successes.

5. CHANGES/PROBLEMS

Changes in approach and reasons for change. Nothing to report

Problems or delays and actions or plans to resolve them. As previously described, the only delay involved the coding of the videotapes that hindered completion of the final 3 subtasks (i.e., subtask 1 – data compilation/quality check; subtask 2 – data analyses; and subtask 3 – dissemination). These 3 subtasks will be completed per the approved Extension without Funds plan (described in detail in a previous section).

Changes that significantly impacted expenditures. Nothing to report

Significant changes in use or care of human subjects. Nothing to report (all research involving human subjects is completed and the IRB protocol has been closed by the local IRB and HRPO).

6. PRODUCTS

Publications (articles, books), conference papers, and presentations. (Year 4)

Rodgers, J. D., Lodi-Smith, J., Donnelly, J. P., Lopata, C., McDonald, C. A., Thomeer, M. L., Lipinski, A. M., Nasca, B. C., & Booth, A. J. (2019). Brief report: Examination of sex-based differences in ASD symptom severity among high-functioning children with ASD using the SRS-2. *Journal of Autism and Developmental Disorders, 49*, 781-787 . doi: 10.1007/s10803-018-3733-4 *[acknowledgement of federal support – YES] Copy of article included in Appendix*

Nasca, B. C., Lopata, C., Donnelly, J. P., Rodgers, J. D., & Thomeer, M. L. (2019). Sex differences in externalizing and internalizing symptoms of children with ASD. *Journal of Autism and Developmental Disorders*. doi: 10.1007/s10803-019-04132-8 *[acknowledgement of federal support – YES] Copy of article included in Appendix*

Lopata, C., Donnelly, J. P., Thomeer, M. L., Rodgers, J. D., Volker, M. A., & Booth, A. J. (in press). Exploratory factor analysis of the Adapted Skillstreaming Checklist for children with ASD.

Autism. 10.1177/1362361319868639 *[acknowledgement of federal support – YES] Copy of proof included in Appendix*

Website(s) or other internet site(s). Nothing to report

Technologies or techniques. Nothing to report

Inventions, patent applications, and/or licenses. Nothing to report

Other products. Nothing to report

7. PARTICIPANTS AND OTHER COLLABORATING ORGANIZATIONS

Individuals who have worked on project

Name:	Christopher Lopata
Project role:	PD/PI
Nearest person month worked:	5
Contribution to project:	No change
Funding support:	

Name:	Marcus L Thomeer
Project role:	Co-PI
Nearest person month worked:	5
Contribution to project:	No change
Funding support:	

Name:	James P Donnelly
Project role:	Co-PI
Nearest person month worked:	3
Contribution to project:	No change
Funding support:	

Name:	Adam Booth
Project role:	Staff Clinician Supervisor
Nearest person month worked:	6
Contribution to project:	No change
Funding support:	

Name: Abigail Kovalick
Project Role: Staff Clinician
Nearest person month worked: 2 (fall 2018 only)
Contribution to Project: No change
Funding support:

Name: Stacy Moppert
Project Role: Staff Clinician and Behavioral Coder
Nearest person month worked: 3
Contribution to Project: No change
Funding support:

Name: Samantha Stanford
Project Role: Research Assistant
Nearest person month worked: 2 (fall 2018 only)
Contribution to Project: Assist with preparation of assessment materials and assessments, conduct fidelity checks, monitor the status of protocol returns and follow-up on missing protocols/items, check and score protocols, load data, and conduct checks for data accuracy.
Funding support:

Name: Maxine McGuire
Project Role: Research Assistant
Nearest person month worked: 2 (fall 2018 only)
Contribution to Project: No change
Funding support:

Name: Julia Jarvis
Project Role: Staff Clinician
Nearest person month worked: 2 (fall 2018 only)
Contribution to Project: No change
Funding support:

Name: Annamaria Monte
Project Role: Staff Clinician and Research Assistant
Nearest person month worked: 3

Contribution to Project: No change
Funding support:

Name: Robia Vedhanayakam
Project Role: Staff Clinician
Nearest person month worked: 2 (fall 2018 only)
Contribution to Project: No change
Funding support:

Name: Shelby Brennan
Project Role: Staff Clinician
Nearest person month worked: 3
Contribution to Project: No change
Funding support:

Name: Samantha Andrews
Project Role: Staff Clinician
Nearest person month worked: 3
Contribution to Project: No change
Funding support:

Name: Christian Conner
Project Role: Staff Clinician
Nearest person month worked: 3
Contribution to Project: No change
Funding support:

Name: Christian Rajnisz
Project Role: Staff Clinician
Nearest person month worked: 2 (spring 2019 only)
Contribution to Project: No change
Funding support:

Name: Meichi Chen
Project Role: Behavioral Coder
Nearest person month worked: 3
Contribution to Project: No change
Funding support:

Name:	Fatima Mitu
Project Role:	Behavioral Coder
Nearest person month worked:	2 (fall 2018 only)
Contribution to Project:	No change
Funding support:	

Changes in other support of the PD/PI(s) or senior/key personnel since last reporting period. Nothing to report

Other organizations involved as partners. Nothing to report

8. SPECIAL REPORTING REQUIREMENTS

None

9. APPENDIX

Articles included in Appendix

APPENDIX

Articles Acknowledging DoD Grant Award

Journal of Autism and Developmental Disorders (2019) 49:781–787
https://doi.org/10.1007/s10803-018-3733-4

BRIEF REPORT

Brief Report: Examination of Sex-Based Differences in ASD Symptom Severity Among High-Functioning Children with ASD Using the SRS-2

Jonathan D. Rodgers[1] · Jennifer Lodi-Smith[1] · James P. Donnelly[1] · Christopher Lopata[1] · Christin A. McDonald[2] · Marcus L. Thomeer[1] · Alanna M. Lipinski[1] · Brian C. Nasca[2] · Adam J. Booth[1]

Published online: 27 August 2018

Abstract

Prior studies of sex-based differences in autism spectrum disorder (ASD) have yielded mixed findings. This study examined ASD symptom severity and functional correlates in a sample of 34 high-functioning females with ASD (HFASD; M age = 8.93; M IQ = 104.64) compared to 34 matched males (M age = 8.96; M IQ = 104.44) using the Social Responsiveness Scale-Second Edition (SRS-2). Results identified non-significant and minimal differences (negligible-to-small) on the SRS-2 total, DSM-5 symptom subscale, and treatment subscale scores. Significant negative (moderate) correlations were found between the SRS-2 Social Cognition subscale and IQ and language scores and between the SRS-2 Social Motivation subscale and receptive language scores for females only; no significant correlations were found for males.

Keywords Autism spectrum disorder · High-functioning · Sex-based differences · Social Communication and Interaction · Social Responsiveness Scale-Second Edition

Autism spectrum disorder (ASD) is defined by two symptom dimensions (deficits in social interaction/communication and restricted and repetitive behaviors, interests, and activities; American Psychiatric Association 2013). According to the most recent CDC estimates, high-functioning children with ASD (HFASD, i.e., without cognitive impairment) now account for a majority of those diagnosed (Christensen et al. 2016). For children with HFASD, the ratio of males-to-females in epidemiological research ranges from 5-to-1 to 16-to-1 (Baird et al. 2006; Christensen et al. 2016). This substantial discrepancy in prevalence makes studies of sex-based differences of clinical phenomenon/presentation difficult due to challenges in securing a sufficient number of comparable female participants (Hull et al. 2017; Kirkovski et al. 2013; Van Wijngaarden-Cremers et al. 2014).

Differences in ASD symptom severity between female and male children is a significant area of research interest. A difference in the severity of core symptoms could indicate sex-based variability in the manifestation of ASD in females versus males and a differential need for supportive services and resources. However, research specifically on individuals with HFASD is very limited. Most past research has focused on broad samples of individuals with ASD across the range of IQ. In this broader literature, past reviews (including meta-analyses) have not identified a consistent difference in the area of social impairment/communication across studies, but do frequently identify differences in the restricted and repetitive behaviors and interests of females versus males (see Kreiser and White 2014; Van Wijngaarden-Cremers et al. 2014), with females showing less identified characteristics in this area. Additionally, much of the past research included in these reviews has not controlled (by design or statistically) for age or IQ, despite these being important considerations in exploring variability in ASD symptoms (Hull et al. 2017; Hus et al. 2013).

In studies specifically about children with HFASD current results are mixed. The available research tends to compare groups using the gold-standard diagnostic measures (the Autism Diagnostic Interview-Revised [ADI-R; Rutter et al. 2003] or Autism Diagnostic Observation Schedule [ADOS; Lord et al. 2000]) which are comprised of symptom counts versus scaled ratings. For example, research

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using the ADI-R found no sex-based differences in a sample of 23 age and IQ matched pairs of children and adolescents with HFASD (Holtmann et al. 2007). However, this same study identified a higher degree of severity in social problems for females using the Child Behavior Checklist (Achenbach 1991), though this rating form is not specific to the social interaction and communication problems of ASD. Research on the ADOS in a sample of IQ equivalent groups (52 females, 273 males) reported a higher degree of restricted and repetitive behaviors, interests, and activities in males than females but no sex-based difference in social interaction/social communication problems (Mandy et al. 2012). Two studies in HFASD have used a measure indicative of symptom severity specifically for ASD (the Social Responsiveness Scale [Constantino and Gruber 2005]) and in these studies a more consistent lack of sex-based differences has been found. In samples of 28 and 20 age and IQ matched pairs no differences on overall ASD symptom severity were identified (May et al. 2014; Solomon et al. 2012). The scarcity and limitations of the previous studies in sex-based symptom differences in children with HFASD support a need for continued examination of this topic.

Current Study

This study was conducted to provide additional information on sex-based differences in ASD symptom severity for children with HFASD. Specifically, this study examines differences in ASD symptom severity for a sample of age- and IQ-matched children with HFASD using the Social Responsiveness Scale-Second Edition (SRS-2; Constantino and Gruber 2012). It also conceptually replicated past work on sex-based differences in ASD symptom severity, a critical need in the social sciences (Tackett et al. 2017). In addition, the association between IQ and language levels and ASD symptom severity were examined within each group. Further, we examined the correlates of the SRS-2 total, DSM-5 and treatment subscale scores with demographic (age and parent education) and functional (cognitive and language) characteristics in order to further explore possible factors related to sex-based differences.

Methods

Participants

A total of 68 children (34 females and 34 males), ages 6–12 years with HFASD comprised the sample. The children were participants in one of several prior psychosocial intervention studies for children with HFASD. Inclusion criteria for those studies were: a prior clinical diagnosis of ASD (with diagnostic confirmation using the ADI-R [Rutter et al. 2003]), Wechsler Intelligence Scales for Children-Fourth Edition (WISC-IV; Wechsler 2003) short-form IQ > 70 (with a verbal comprehension or perceptual reasoning index composite ≥ 80), and Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk 1999) short-form receptive or expressive language composite ≥ 80. The WISC-IV short-form consisted of the Block Design, Similarities, Vocabulary, and Matrix Reasoning subtests and the CASL short-form consisted of the Antonyms, Synonyms, Syntax Construction, and Paragraph Comprehension subtests. The only exclusion criterion for the prior studies was severe physical aggression because the psychosocial interventions being examined target primarily social interaction and social-communication skills.

The sample was 92.65% Caucasian with an average parent education of 15.12 years. Some participants had comorbid diagnoses of or received pharmacological treatment for anxiety, depression, or attention-deficit/hyperactivity disorder (ADHD), based on parent report. See Table 1 for a summary of the sample characteristics by group.

Procedures

The study was conducted using screening and pre-test scores from children participating in multiple clinical intervention trials at a university research center. The intervention studies from which the data were drawn were approved by an Institutional Review Board and completed according to the approved protocol. Parent informed consent and child assent were obtained. Recruitment for these trials was through public advertisements including announcements from community partners and school districts. All female participants meeting inclusion criteria from these trials were included in the current sample ($n = 34$). Matching was then conducted individually using the available pool of males ($n = 307$) who had also met inclusion criteria as part of their participation in the prior intervention studies. Participants were matched on age and IQ, as these are critical considerations in the interaction of sex and ASD characteristics (Hull et al. 2017; Hus et al. 2013). Male-matches were identified within 12 months of age and 10 short-form IQ points for each female. These criteria were selected because 12 months of age is a specific yet feasible (for matching purposes) developmental window and 10 standard score points of IQ is the basis for clinical ranges on the WISC-IV. If multiple matches were identified, an individual male match was randomly selected using the randomized list generator available from http://www.random.org (Haahr 1998). Matching was also attempted for majority (Caucasian) and minority (non-Caucasian or mixed-race) status however one minority female could not be matched to a minority male on age and cognitive function. In this case, a Caucasian male was matched with the minority female.

Table 1 Sample characteristics by sex

	Females ($n=34$)		Males ($n=34$)		Gender contrast		
	Mean	SD	Mean	SD	t (66)	p	d
Matched variables							
Age	8.93	1.78	8.96	1.72	−0.08	0.939	−0.019
WISC-IV							
Short-form IQ	104.64	16.04	104.44	13.99	0.06	0.956	0.013
Short-form VCI	104.03	16.09	104.10	14.15	−0.02	0.986	−0.004
Short-form PRI	104.74	16.40	103.84	16.53	0.23	0.822	0.055
% Caucasian	91.18%		94.12%		Fisher's exact test $p=0.500$		
Non-matched variables							
Parent education	15.32	2.13	14.91	1.70	0.88	0.382	0.214
ADI-R							
RSI	18.35	4.92	19.03	5.83	−0.52	0.607	−0.125
SC	13.94	4.64	15.41	3.85	−1.42	0.160	−0.345
RRSB	5.21	2.00	5.65	2.42	−0.82	0.416	−0.199
CASL							
Expressive language	99.64	17.21	99.81	17.18	−0.04	0.968	−0.010
Receptive language	101.84	15.81	106.76	14.03	−1.36	0.180	−0.329
Comorbid diagnoses							
Anxiety	8.82%		5.88%		Fisher's exact test $p=0.500$		
Depression	5.88%		5.88%		Fisher's exact test $p=0.693$		
ADHD	35.29%		41.18%		Fisher's exact test $p=0.402$		

WISC-IV Wechsler Intelligence Scale for Children-4th Edition, *VCI* Verbal Comprehension Index, *PRI* Perceptual Reasoning Index, *ADI-R* autism diagnostic interview-revised, *RSI* reciprocal social interaction, *SC* social communication, *RRSB* restricted, repetitive, and stereotyped behaviors, *CASL* comprehensive assessment of spoken language, *ADHD* attention-deficit/hyperactivity disorder

Measure

Social Responsiveness Scale, Second Edition, School Age Form (SRS-2)

The SRS-2 (Constantino and Gruber 2012) was completed by a parent or caregiver and was used to assess ASD symptom severity. The SRS-2 is a 65-item measure of ASD-related behaviors to assist in diagnosis, treatment planning, and progress monitoring. The SRS-2 items use a Likert scale with item values of 1 = Not True, 2 = Sometimes True, 3 = Often True, and 4 = Almost Always True. Item values are combined into subscales to provide a gradient of continuous values to measure symptom severity and frequency.

The current study used the raw scores from the total, DSM-5 symptom scales, and treatment subscales. Constantino and Gruber (2012) recommended that raw scores be used when examining group characteristics and differences in research studies. This is especially warranted in studies of sex-based differences because SRS-2 standard scores are derived based on sex-specific norm-reference groups (i.e., separate normative samples and standard scores for females and for males). The use of sex-specific normative samples and derivation of standard scores based on sex does not allow for the use of standard scores to compare sex-based differences in symptom severity; the use of untransformed raw scores allows for a direct comparison of ASD symptom severity using the SRS-2. The total score includes all 65 items with a raw score range of 0–195. The two DSM-5 symptom subscales measure the primary symptom dimensions of ASD including Social Communication and Interaction (SCI; 53 items) and Restricted Interests and Repetitive Behavior (RIRB; 12 items). The SRS-2 also yields five treatment subscale scores including Social Awareness (8 items; representing the ability to pick up social cues), Social Cognition (12 items; representing the interpretation of social cues), Social Communication (22 items; representing the expressive aspects of social interaction), Social Motivation (11 items; representing the willingness to engage in social interaction), and Restricted Interests and Repetitive Behavior (12 items; representing stereotyped and/or repetitive interests and behaviors). The first four treatment subscales combined comprise the DSM-5 SCI symptom subscale and the RIRB treatment subscale is identical to the DSM-5 RIRB symptom scale.

Validation studies reported in the test manual have indicated that the SRS-2 total score accurately detects ASD characteristics and discriminates ASD from other clinical

disorders (see Constantino and Gruber 2012). Internal consistency of the total raw score reportedly ranges from 0.91 to 0.97 across a range of studies and samples (see Constantino and Gruber 2012). While independent reliability and validity on the DSM-5 and treatment subscales of the SRS-2 have not been established, we use these scales for exploratory purposes.

Analyses

There were no missing data. The studies that generated the data instituted specific protocols for data processing and quality checks. All SRS-2 protocols were reviewed for completeness upon return and any errors in completion (e.g., omitted items) were immediately reviewed with the respondent and corrected. Each protocol was scored independently by two research assistants using the SRS-2 computer scoring software program and the resulting scores (along with other study data) were entered into the study database and independently checked by another research assistant. Any scoring or entry discrepancies were resolved by a third team member. Analyses were conducted in SPSS and R. Between-group comparability based on demographic and screening data was tested using independent samples *t* tests for continuous variables and Fisher's exact tests for categorical variables. Between-group differences in ASD symptom severity (SRS-2 scores) were tested using independent samples *t* tests and effect size estimates (Cohen's *d*) were provided. Levene's test confirmed homogeneity of variance for all study variables. Tukey's test was used to identify outliers outside the 1.5 interquartile range. Three potential outliers were identified in the SRS-2 subscales. These were confirmed as valid data points and retained for analyses. Anderson–Darling tests of normality confirmed that all SRS-2 variables were normally distributed. The associations between IQ and language scores and ASD symptom severity scores were calculated using Pearson's *r* for each group separately. The sample of 68 has sufficient power to detect an effect size (*d*) of 0.69 with power of 0.80 (two-tailed alpha set to 0.05). Within the female and male subgroups, a correlation of 0.33 can be detected in each group of 34 cases with power of 0.80 (two-tailed alpha = 0.05). Significance levels are reported alongside effect sizes for all analyses.

Results

Initial tests supported the comparability of the male and female samples on major demographic characteristics and screening measures scores (see Table 1). Overall, the male and female samples did not significantly differ on age, IQ, ethnicity, parent education, ADI-R scores, language level, or proportion of comorbid diagnoses. Given the high level of comparability on these variables, statistical adjustment was not warranted for the comparison of symptom severity between groups.

Between-group tests of ASD symptom severity yielded no statistically significant differences between female and male children with HFASD (Table 2). The lack of difference in symptom severity between groups was also evident in the effect sizes which were negligible for the total, DSM-5 symptom scales, and all but one of the treatment subscales (*d*s from 0.07 to 0.10); only the Social Motivation subscale had an effect size that reached the small range ($d = 0.28$).

Correlations between the children's demographic and functional variables and SRS-2 total, DSM-5 subscales, and treatment subscales scores were also examined (Table 3). No significant correlations were found for males between any of the WISC-IV scores and CASL language scores and ASD symptom severity scores, and the magnitudes of the correlations were negligible ($r \leq 0.19$) for all but one scale. For females, significant negative correlations were found between the SRS-2 Social Cognition treatment subscale and WISC-IV full-scale and verbal comprehension IQ scores and CASL receptive and expressive language scores; these correlations were of moderate magnitude (*r*s ranging

Table 2 SRS-2 scales by sex

	Females ($n = 34$)		Males ($n = 34$)		Sex-based contrast		
	Mean	SD	Mean	SD	t (66)	p	Cohen's d
SRS-2 total	99.44	26.51	97.56	29.34	0.28	0.782	0.067
SCI	81.12	22.76	78.74	23.34	0.43	0.671	0.103
SA	12.68	4.04	12.32	3.14	0.40	0.689	0.098
SCOG	18.18	5.98	18.65	6.89	−0.30	0.765	−0.073
SCOM	34.15	10.68	33.21	11.04	0.36	0.722	0.087
SMOT	16.12	5.80	14.56	5.54	1.13	0.262	0.275
RIRB	18.32	6.13	18.82	6.63	−0.32	0.748	−0.078

SRS-2 Social Responsiveness Scale-2nd Edition, *SCI* Social Communication and Interaction, *SA* Social Awareness, *SCOG* Social Cognition, *SCOM* Social Communication, *SMOT* Social Motivation, *RIRB* Restricted Interests and Repetitive Behaviors

Table 3 Correlations of sample characteristics with SRS-2 raw scores by sex

	Total		SCI		SA		SCOG		SCOM		SMOT		RIRB	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Females ($n=34$)														
Age	0.13	0.464	0.10	0.574	0.01	0.955	−0.12	0.499	0.19	0.282	0.15	0.397	0.18	0.308
Parent education	−0.03	0.866	−0.03	0.866	−0.02	0.911	−0.26	0.138	0.07	0.694	0.02	0.911	−0.03	0.866
WISC-IV														
Short-form IQ	−0.18	0.308	−0.23	0.191	−0.04	0.822	−0.36	0.036	−0.16	0.366	−0.23	0.191	0.09	0.613
Short-form VCI	−0.16	0.366	−0.21	0.233	−0.12	0.499	−0.38	0.027	−0.08	0.653	−0.21	0.233	0.09	0.613
Short-form PRI	−0.15	0.397	−0.18	0.308	0.05	0.779	−0.23	0.191	−0.18	0.308	−0.19	0.282	0.05	0.779
CASL														
Expressive	−0.17	0.336	−0.22	0.211	−0.10	0.573	−0.36	0.036	−0.08	0.653	−0.25	0.154	0.05	0.779
Receptive	−0.29	0.096	−0.34	0.049	−0.11	0.536	−0.49	0.003	−0.22	0.211	−0.35	0.042	0.00	0.999
Males ($n=34$)														
Age	0.02	0.911	0.00	0.999	−0.11	0.536	−0.03	0.866	0.03	0.866	0.03	0.866	0.08	0.653
Parent education	0.20	0.257	0.23	0.191	0.10	0.574	0.33	0.057	0.18	0.308	0.14	0.430	0.09	0.613
WISC-IV														
Short-form IQ	−0.07	0.694	−0.06	0.736	0.09	0.613	−0.09	0.613	−0.08	0.653	−0.03	0.866	−0.10	0.574
Short-form VCI	−0.04	0.822	−0.03	0.866	0.16	0.366	−0.02	0.911	−0.11	0.536	0.03	0.866	−0.08	0.653
Short-form PRI	−0.07	0.694	−0.07	0.694	−0.01	0.955	−0.12	0.499	−0.03	0.866	−0.07	0.694	−0.09	0.613
CASL														
Expressive	−0.19	0.282	−0.15	0.397	0.12	0.499	−0.15	0.397	−0.19	0.282	−0.16	0.366	−0.28	0.109
Receptive	0.00	0.999	0.03	0.866	0.18	0.308	−0.04	0.822	0.01	0.955	0.03	0.866	−0.11	0.536

SRS-2 Social Responsiveness Scale-2nd Edition, *SCI* Social Communication and Interaction, *SA* Social Awareness, *SCOG* Social Cognition, *SCOM* Social Communication, *SMOT* Social Motivation, *RIRB* Restricted Interests and Repetitive Behaviors, *WISC-IV* Wechsler Intelligence Scale for Children-4th Edition, *VCI* Verbal Comprehension Index, *PRI* Perceptual Reasoning Index, *CASL* comprehensive assessment of spoken language

from −0.36 to −0.49). A significant negative correlation of moderate magnitude ($r=-0.35$) was also observed between the SRS-2 Social Motivation treatment subscale scores and CASL receptive language scores for females. All other correlations were non-significant and generally of weak/negligible strength for the female sample. Figure 1 illustrates the differential relationships in females and males using the strongest of these differences, receptive language to Social Cognition.

Discussion

The current study compared ASD symptom severity (i.e., SRS-2 total, DSM-5 symptom scales, and treatment subscales) scores for a well-characterized sample of females with HFASD to a sample of males with HFASD matched on age and IQ. Findings suggested no meaningful differences between female and male children with HFASD on the severity of symptoms or on the DSM-V symptom subscales/treatment subscales. Thus, the overall pattern of results suggests equivalence of female and male children with HFASD for the severity of the core symptom areas of ASD. This is generally consistent with past research exploring sex-based differences in symptom severity for children with HFASD, and thus conceptually replicates and extends previous findings (May et al. 2014; Solomon et al. 2012). Of particular note is the lack of differences in restricted, repetitive and stereotyped behaviors between male and female children with HFASD. This null finding is consistent with some (Solomon et al. 2012) but not all literature in this area (Kreiser and White 2014; Mandy et al. 2012; Van Wijngaarden-Cremers et al. 2014). Future research in a well-characterized and matched sample should consider this area using a more detailed measure of these behaviors. The current findings also do not specifically support the presence of a female-specific autism phenotype that may differ from the more commonly understood male phenotype (see Van Wijngaarden-Cremers et al. 2014), as expressed in symptom severity on the SRS-2. It is important to note that, while absolute severity of symptoms do not appear to be different, there is the possibility that male and female individuals respond differently to interventions and services and thus future studies should consider this point.

A unique finding of the current study was the differential relationships found between functional level variables

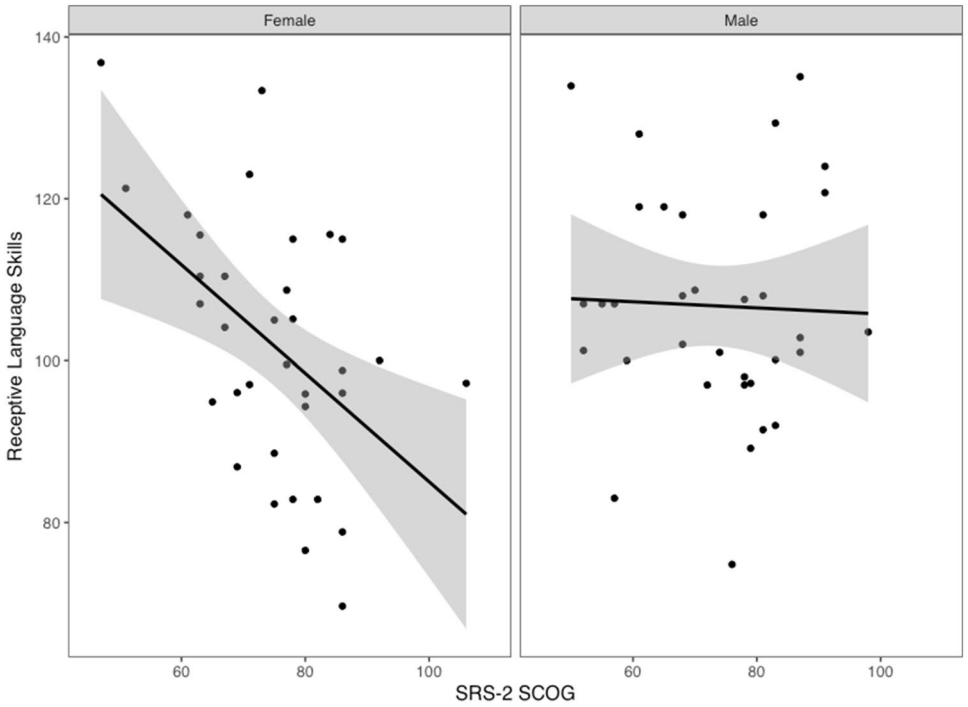

Fig. 1 Correlation of SRS-2 Social Cognition Raw Score with CASL receptive language skills by sex

(IQ and language) and ASD symptom severity for females with HFASD compared to males with HFASD. For male children with HFASD, IQ and receptive and expressive language levels were not associated with parent rated overall ASD symptom severity or with the DSM-5 symptom scales or treatment subscales. For female children with HFASD, IQ and receptive and expressive language were also unrelated to symptom severity, the DSM-5 symptom scales, and the Social Awareness and Social Communication treatment subscales. However, correlations on four of the five cognitive/language measures and the Social Cognition subscale were statistically significant and moderate in magnitude and receptive language and Social Motivation were significantly and moderately associated. More specifically, higher verbal ability and/or language skills were associated with lower Social Cognition and Social Motivation symptom severity. These results suggest that language abilities and receptive language skills in particular may play a unique role in the understanding and interpretation of social cues in females. However, further work is needed to explore these relationships and identify if this relationship is specific to HFASD, replicates in more nuanced symptom measures, and is present in the general population or unique to HFASD.

Strengths and Limitations

This is the largest study to date to examine sex-based differences in ASD symptom severity for matched children with HFASD using a continuous measure, and the only to use the SRS-2, a common and well-validated measure of ASD symptom severity. It included a relatively large and well-characterized sample of female children with HFASD that was individually and carefully matched to male children with HFASD. Another strength was the examination of sex-based differences using a measure that employs continuous scaling; this allows for a better assessment of the severity of ASD symptoms/impairments (vs a categorical or symptom count metric; Achenbach 2011; Constantino and Gruber 2012).

Despite the study's relatively large sample and contribution to the research on sex-based differences in ASD symptom severity for children with HFASD, the sample was none-the-less limited in both representativeness and size. Specifically, the sample was predominantly Caucasian, from well-educated families, and all of the children were high-functioning (IQ and language) and excluded if they showed severe physical aggression; this limits the generalizability of the findings to the broader ASD population. The present sample only had sufficient power to detect large but not small effects and thus may have been underpowered to identify more subtle group differences. In addition, the number of analyses conducted was large for the sample size, particularly without correction for multiple comparisons. Because of this attention should be paid to effect size estimates rather than significance values and, in particular, the findings related to the correlations between functional variables and Social Cognition and Social Motivation should be considered tentative.

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Author Contributions JDR conceived of the study, participated in its design, collected and coordinated the data, and drafted the manuscript; JLS contributed to the study design, conducted the statistical analyses, assisted in interpretation of the data, and contributed to manuscript preparation; JPD participated in the design, conducted the statistical analyses, and assisted in the interpretation of the data and preparation of the manuscript; CL participated in the study design and contributed to manuscript preparation; CAM participated in the study design, assisted with data coordination, and contributed to manuscript preparation; MLT participated in the study design and manuscript preparation; AML assisted in data collection, data management, and manuscript preparation; BCN assisted in data collection, data management, and manuscript preparation; AJB assisted in data collection, data management, and manuscript preparation. All authors read and approved the final manuscript.

Compliance with Ethical Standards

Ethical Approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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ORIGINAL PAPER

Sex Differences in Externalizing and Internalizing Symptoms of Children with ASD

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Abstract
This study examined sex differences in externalizing and internalizing symptoms of children with ASD without intellectual disability (ID). The sample ($n = 80$) included 40 girls and 40 boys, ages 6–12 years, with ASD (without ID) matched on age and IQ. Externalizing and internalizing symptoms were significantly elevated for this sample (girls and boys) relative to normative estimates for all the scales (hyperactivity, aggression, anxiety, and depression) except conduct problems. No significant differences were found between girls and boys for either externalizing symptoms or internalizing symptoms (based on standard score and raw score analyses). Implications for clinical practice and future research are discussed.

Keywords Sex differences · Externalizing symptoms · Internalizing symptoms · Children with ASD (without intellectual disability)

Introduction

There has been a significant increase in the number of children with autism spectrum disorder (ASD) including among children with ASD without intellectual disability (ID) who currently constitute approximately two-thirds of those diagnosed (Baio et al. 2018). Disparities in the prevalence of ASD by sex have long been documented, with the most recent data indicating a 4:1 male-to-female ratio for the broad ASD population and an even greater disparity among those with ASD without ID (Baio et al. 2018). The substantial prevalence discrepancy has led researchers to examine sex differences for a range of phenotypic variables (e.g., diagnostic symptoms, adaptive skills, etc.; Giarelli et al. 2010; Harrop et al. 2015; Rodgers et al. 2019). These studies have sought to inform assessment and treatment practices, as well as identify potential causal mechanisms for ASD and the male–female prevalence discrepancy (Kuusikko et al. 2008; May et al. 2014, 2016).

Beyond the core diagnostic symptoms, individuals with ASD have been found to exhibit a range of comorbid psychiatric symptoms that can further interfere with daily functioning (e.g., Gadow et al. 2005; Volker et al. 2010). Elevations in comorbid symptoms including ADHD-related symptoms have been reported in these studies despite the exclusionary parameters for a comorbid diagnosis of ADHD contained in the DSM-IV and DSM-IV-TR (APA 1994, 2000) that were frequently used to enroll participants. The common occurrence of comorbid symptoms in ASD has prompted studies into potential sex differences in externalizing and internalizing symptoms. Although the research is somewhat limited, the majority of studies have tested sex differences in these symptoms using functionally-heterogeneous samples (variable cognitive levels), with fewer studies using more functionally-homogeneous samples (ASD without ID; Mandy et al. 2012).

Studies of sex differences in externalizing symptoms using functionally-heterogeneous samples with ASD have yielded inconsistent results. For example, a large-scale review of behavioral records found higher levels of parent-rated externalizing symptoms (aggression, hyperactivity, and inattention) for boys with ASD compared to girls with ASD (Giarelli et al. 2010). In contrast, Frazier et al. (2014) found higher levels of parent-rated externalizing behaviors

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for child and adolescent girls with ASD relative to affected boys (total externalizing problems and irritability). Still others have found no sex differences on a range of externalizing symptoms in children and adolescents with ASD (e.g., oppositional behaviors, disruptive behaviors, conduct problems, hyperactivity/inattention, aggression; Brereton et al. 2006; Mandy et al. 2012; Postorino et al. 2015). Contradictory findings have also been reported for sex difference in internalizing symptoms, with some data indicating higher levels of parent-rated emotional problems for female youth with ASD compared to male youth with ASD (Mandy et al. 2012) and other data indicating no internalizing symptom (depression, anxious/depressed, withdrawn) sex differences for youth with ASD (Brereton et al. 2006; Postorino et al. 2015). Several authors have asserted that the contradictory findings are likely associated with the wide and variable range of cognitive/functional levels in samples that can mask important differences, and that studies are needed using functionally-homogeneous ASD samples (Lai et al. 2011; Mandy et al. 2012).

Given the potential effect(s) of cognitive level on results, some researchers have begun to test sex differences in comorbid symptoms in more homogeneous samples consisting of youth specifically with ASD without ID. These studies have also produced inconsistent findings (Oswald et al. 2016). For example, when examining sex differences in parent-rated externalizing symptoms, Worley and Matson (2011) reported no differences in tantrum behaviors or conduct problems for children and adolescents with ASD without ID. Holtmann et al. (2007) found female children and adolescents with ASD without ID had higher parent-rated inattention problems than males with ASD without ID; however, females and males did not differ on delinquent or aggressive behaviors. May et al. (2014) found no sex differences in ratings of inattention or aggression symptoms for children with ASD without ID but males had more symptoms of hyperactivity. In a subsequent study, May et al. (2016) also found more symptoms of hyperactivity/impulsivity, as well as inattention for boys with ASD without ID than girls with ASD without ID. Studies of internalizing symptoms have also produced inconsistent findings however no studies were identified indicating more internalizing symptoms for male youth than female youth with ASD without ID. To illustrate, several studies found no sex differences in parent-rated anxiety, depression, and/or withdrawal symptoms for children and adolescents with ASD without ID (Holtmann et al. 2007; Kuusikko et al. 2008; Solomon et al. 2012; Worley and Matson 2011); however, Solomon et al. (2012) also reported that when they examined only the subgroup of adolescents in their sample (ages 12–18 years), the females had higher levels of anxiety than males (no differences were reported for depression symptoms among the adolescents). May et al. (2014) also found higher parent ratings of social anxiety in girls with ASD without ID than affected boys and Oswald et al. (2016) reported higher parent-rated depression symptoms for adolescent females than adolescent males with ASD without ID (anxiety symptoms were comparable).

Although these studies provide important information on potential sex differences in comorbid symptoms in youth with ASD without ID, the findings have yet to render clear conclusions and a number of variables and limitations have likely contributed to the disparate results (Solomon et al. 2012). For example, the studies of youth with ASD without ID described had very small samples of females (ranging from 12 to 32) and many included both children and adolescents. The small samples and inclusion of youth from broad age ranges were likely associated with significant difficulty recruiting sufficient numbers of females due to the male–female prevalence disparity which is even greater among youth with ASD without ID (Harrop et al. 2015; May et al. 2016). However, broad age ranges can obscure sex differences (Worley and Matson 2011). Many studies also failed to control the statistical error rate despite conducting numerous comparisons, although some applied corrections to control family-wise error rates. A number of studies utilized matched samples (age and/or IQ) which is important given the significant challenges in enrolling females with ASD without ID (Frazier et al. 2014; Lai et al. 2011; Oswald et al. 2016). Lastly, some of the variability in results may be related to the scores used in the analyses as some studies used norm-referenced standard scores and others used raw scores. Although standard scores may assist in determining severity and/or the clinical range of those in the sample, they may also mask potential sex differences (Solomon et al. 2012); studies should include both types of scores (Frazier et al. 2014). This study addressed these limitations and was conducted to contribute to the research by testing sex differences in comorbid symptoms using a relatively large and matched sample of girls and boys with ASD without ID and a narrower age range. The study utilized a multivariate approach and statistical corrections to control experiment-wise error and the analyses were conducted for both standard scores and raw scores. Given the highly discrepant findings in the existing studies, no specific hypothesis was evident for externalizing symptom levels but it was anticipated that boys in the sample would not receive significantly higher ratings of internalizing symptoms than girls in the sample.

Method

Participants

The total sample was comprised of 80 children, ages 6–12 years, with ASD without ID including 40 girls and

40 boys matched on age and IQ. Data for this study were derived from databases of prior clinical studies testing various psychosocial treatments for children with ASD without ID. Recruitment for those trials was done via public announcements. Specifically, recruitment flyers were distributed by public school personnel and local clinicians (counselors, psychologists, etc.) to parents of potential participants in the community. Interested parents then contacted a study coordinator to learn about the studies and eligibility requirements.

Eligibility for the studies was determined using a multiple-gate screening procedure. Initially, parents submitted documentation of a prior clinical diagnosis of autism, Asperger's, or Pervasive Developmental Disorder-Not Otherwise Specified (PDDNOS), as well as prior psychological and special education reports. All the children received their diagnoses from 2002 to 2012 per the DSM-IV-TR (APA 2000). Next, the documentation and reports were independently reviewed by two senior members of the research team using a standardized checklist documenting prior IQ scores (if available; minimum IQ score of 70) and evidence of social/social-communication impairments and circumscribed and repetitive behaviors and interests; consensus between the two reviewers indicating that the criteria were met was required. Children meeting criteria then participated in a formal assessment session that included cognitive testing using a 4-subtest short-form of the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV; Wechsler 2003) and informal observations of their symptoms, skills, and behaviors. The WISC-IV 4-subtest short-form consisted of the Vocabulary, Similarities, Block Design, and Matrix Reasoning subtests. The short-form composite score had an internal consistency reliability of 0.95 and correlated 0.92 with the Full Scale IQ of the complete test. The methods described by Tellegen and Briggs (1967) were used to calculate the composite reliability, correlation with the full test, and deviation quotient formula based on standardization information in the test manual. Following the formal assessment session, each complete file was again independently reviewed by two senior research team members using the standardized checklist and consensus was required that the child met inclusion criteria (i.e., ages 6–12 years, WISC-IV short-form IQ > 70, and clinical consensus supporting the prior diagnosis) to be enrolled in the trials. One of the studies included an additional exclusionary criterion involving a history of psychosis (per parent report). Other comorbid diagnoses were not assessed as part of the original studies, no specific data were collected on those, and there were no specific exclusionary criteria for other comorbid diagnoses.

The matched-samples for this study were predominately Caucasian, had mean IQ scores in the average range, and had comparable parent education levels. No significant differences were found between the girl and boy samples on major demographic characteristics (see Table 1 for demographics and results of between-groups demographic comparisons). The number of girls and boys taking a psychotropic medication was also very similar across the groups (15 of 40 girls and 17 of 40 boys) with ADHD medication by far the most common in both groups (11 of the 15 girls and 12 of the 17 boys). Data on comorbid symptoms used in this study were collected between 2008 and 2017 and, as noted, all the children received their diagnoses per the DSM-IV-TR, were recruited from the community, and were enrolled in a psychosocial (clinical) treatment study.

Measure

Behavior Assessment System for Children, Second Edition, Parent Rating Scales (BASC-2 PRS)

The BASC-2 PRS (Reynolds and Kamphaus 2004) is a standardized multidimensional rating scale used to assess a range of clinical symptoms in order to assist with differential diagnosis, intervention planning, and outcome monitoring. The BASC-2 PRS is available for three age groups, with this study utilizing the Child (6-to-11 years; PRS-C) and Adolescent (12-to-21 years; PRS-A) forms to assess externalizing and internalizing symptoms. The BASC-2 has consistent

Table 1 Demographic characteristics of the study samples

Characteristic	Boys ($n = 40$) Mean (*SD*)	Girls ($n = 40$) Mean (*SD*)	*t* value	*p* value
Age (years)	9.03 (1.76)	8.95 (1.80)	−0.19	0.85
IQ	103.35 (13.75)	103.25 (15.93)	−0.03	0.98
Parent education (years)	15.10 (1.70)	15.33 (2.22)	0.51	0.66
	n (% of total)	*n* (% of total)		Fisher's exact (*p*)
Ethnicity	Caucasian = 36 (90.0%) Minority = 4 (10.0%)	Caucasian = 35 (87.5%) Minority = 5 (12.5%)		1.00

scales across age levels which, "provides a basis for consistent interpretation of scales" (Reynolds and Kamphaus 2004, p. 2). Both forms include nine clinical behavior scales (i.e., Aggression, Anxiety, Attention Problems, Atypicality, Conduct Problems, Depression, Hyperactivity, Somatization, and Withdrawal); this study used the Hyperactivity, Conduct Problems, and Aggression scales to assess externalizing symptoms and Depression and Anxiety scales to assess internalizing symptoms. Parents rate each item on a 4-point frequency scale from 0 (Never) to 3 (Almost always) and item scores are summed and converted to standard *T*-scores ($M = 50$, $SD = 10$). Higher scores on the clinical scales indicate more problematic symptoms/behaviors. Clinical scale *T*-scores between 41and 59 are considered *average*, scores between 60 and 69 are classified as *at-risk*, and scores ≥ 70 are classified as *clinically significant* (Reynolds and Kamphaus 2004).

Coefficient alpha reliabilities for the PRS-C clinical scales used in this study reportedly ranged from 0.83 to 0.88 and for the PRS-A ranged from 0.81 to 0.87. Validity evidence supporting the grouping of externalizing or internalizing scales is reflected in moderate intercorrelations between scales within each grouping. Intercorrelations between the externalizing behavior scales (i.e., Hyperactivity, Aggression, and Conduct Problems) ranged from 0.67 to 0.76 for the PRS-C and 0.72 to 0.78 for the PRS-A and between the two internalizing behavior scales (i.e., Depression and Anxiety) was 0.54 for the PRS-C and 0.59 for the PRS-A. Concurrent validity was supported in moderate-to-high correlations between the BASC-2 scales used in this study and comparable clinical scales on other established rating scales (Reynolds and Kamphaus 2004). Additionally, studies have shown that the BASC-2 is sensitive to externalizing and internalizing symptoms in children and adolescents with ASD without ID when compared to typically-developing peers (Lopata et al. 2010; Volker et al. 2010).

Procedures

The treatment trials that generated the data used in this study were approved by the Institutional Review Board and conducted according to the approved procedures (including attainment of written parental consent and child assent). For each trial, parents completed a battery of pretreatment (baseline) measures that included the BASC-2 PRS. Once completed and returned, each protocol was immediately examined for any errors (e.g., items with multiple responses, omitted items, etc.) and promptly reviewed with the parent to correct the error(s). All protocols were scored by research assistants using the BASC-2 ASSIST Plus computer scoring software, which includes a second entry check for accuracy. Protocol and demographic data were initially entered into the study database by a research assistant and independently checked by a second research assistant, with any discrepancy resolved by a third member of the team.

Data Analysis Plan

Several statistical procedures were used to examine the externalizing and internalizing symptoms of girls and boys in the sample. Initially, descriptive statistics were calculated for the girl and boy samples including demographic data (Table 1) and scores on each of the externalizing and internalizing scales (both standard *T*-scores and raw scores; Table 2). Next, one-sample *t*-tests were calculated using the standard scores to compare the symptom levels of girls and boys separately against the BASC-2 normative estimates. These comparisons were conducted to characterize the symptom levels and assist with subsequent interpretation of the principle tests of sex differences in symptoms. A Bonferroni correction was applied for each sex-based set of comparisons (girl sample adjusted alpha ≤ 0.01 [i.e., 0.05/5 comparisons] and boy sample adjusted alpha ≤ 0.01 [i.e., 0.05/5 comparisons]). Effect size estimates (Cohen's *d*) were also calculated.

The primary research questions involving sex differences in externalizing and internalizing symptoms were tested using Multivariate Analysis of Variance (MANOVA). Two separate MANOVAs were calculated for the standard scores (one for externalizing symptoms and one for internalizing symptoms) and two for the raw scores (one for externalizing symptoms and one for internalizing symptoms). In this study, the Hyperactivity, Aggression, and Conduct Problems scales comprised the externalizing behavior sets and

Table 2 BASC-2 PRS means and standard deviations for standard scores and raw scores by group

Scale	Boys *T*-score Mean (*SD*)	Girls *T*-score Mean (*SD*)	Boys raw score Mean (*SD*)	Girls raw score Mean (*SD*)
Hyperactivity	64.73 (13.80)	64.80 (11.42)	13.95 (6.35)	14.00 (5.15)
Aggression	57.35 (12.15)	54.63 (9.99)	9.28 (5.28)	7.90 (4.59)
Conduct problems	50.88 (12.44)	52.28 (11.19)	5.30 (4.64)	5.70 (3.96)
Anxiety	57.73 (16.23)	58.30 (14.32)	16.68 (9.62)	16.80 (8.25)
Depression	62.75 (15.80)	62.35 (16.50)	13.03 (8.01)	12.65 (8.12)

All values based on $n = 40$ boys and $n = 40$ girls

the Anxiety and Depression scales comprised the internalizing behavior sets. To control the experiment-wise error rate at 0.05, each MANOVA was tested at the adjusted alpha <0.0125 (i.e., 0.05/4 MANOVA tests). Assumptions of the MANOVA models (outliers, normality, linearity, and homogeneity of variance–covariance matrices) were assessed and all were met. Linear correlations among the externalizing scales and among the internalizing scales were all of moderate magnitude (Table 3). MANOVA tests were done using Pillai-Bartlett trace, and follow-up univariate F tests were calculated. Partial eta squared effect sizes were also calculated (Table 4).

Results

Initial tests compared the externalizing and internalizing symptom levels of girls and boys in the sample separately against the BASC-2 normative estimates. Results of the one-sample t-tests yielded significantly higher externalizing symptom levels for girls and boys in the sample on the Hyperactivity (girls $t=8.20$, $p<0.01$, $d=1.38$ and boys $t=6.75$, $p<0.01$, $d=1.22$) and Aggression (girls $t=2.93$, $p=0.01$, $d=0.46$ and boys $t=3.83$, $p<0.01$, $d=0.66$) scales but no differences on the Conduct Problems (girls $t=1.29$, $p=0.21$, $d=0.22$ and boys $t=0.45$, $p=0.66$, $d=0.08$) scale. Results also indicated significantly higher internalizing symptoms for girls and boys in the sample for the Anxiety (girls $t=3.67$, $p=0.01$, $d=0.67$ and boys $t=3.01$, $p=0.01$, $d=0.57$) and Depression (girls $t=4.73$, $p<0.01$, $d=0.91$ and boys $t=5.11$, $p<0.01$, $d=0.96$) scales. For the four scales on which significant differences were found, the effect sizes were generally medium-to-large in magnitude.

Potential sex differences for the externalizing and internalizing symptom scales were first tested using the standard scores. Results of the separate MANOVA analyses revealed no significant multivariate effect of sex for externalizing or internalizing symptoms, indicating similar levels of parent-reported symptoms across the sex groups (Table 4). Given the absence of a significant multivariate effect for either the externalizing symptoms or internalizing symptoms tests, the univariate F tests are reported but the significance tests are not interpreted. A review of the univariate effect sizes, however indicated small-to-negligible effects for each of the individual externalizing and internalizing scales. For the same tests using the raw scores, the MANOVA analyses also indicated no significant multivariate effect of sex for either externalizing symptoms or internalizing symptoms.

Table 3 BASC-2 PRS scale correlations for standard scores and raw scores

Clinical scale	Hyperactivity	Aggression	Conduct problems	Anxiety	Depression
Hyperactivity	–	0.66**	0.51**	0.22**	0.46**
Aggression	0.63**	–	0.78**	0.18	0.56**
Conduct problems	0.45**	0.78**	–	0.12	0.55**
Anxiety	0.25*	0.17	0.06	–	0.60**
Depression	0.40*	0.56**	0.53**	0.58**	–

Upper off correlations based on standard T-scores and lower off based on raw scores

*$p<0.05$; **$p<0.01$

Table 4 Multivariate and univariate results for sex comparisons for externalizing and internalizing symptoms

Effect	T-score comparisons				Raw score comparisons			
	Pillai's trace	F (df)	P value	Partial eta squared	Pillai's trace	F (df)	P value	Partial eta squared
Multivariate test								
Externalizing behavior	0.09	2.54 (3,78)	0.06	0.09	0.10	2.81 (3,78)	0.05	0.10
Univariate tests								
Hyperactivity		<0.01 (1,78)	0.98	<0.01		<0.01 (1,78)	0.97	<0.01
Aggression		1.20 (1,78)	0.28	0.02		1.55 (1,78)	0.22	0.02
Conduct problems		0.28 (1,78)	0.60	<0.01		0.17 (1,78)	0.68	<0.01
Multivariate test								
Internalizing behavior	<0.01	0.05 (2,78)	0.95	<0.01	<0.01	0.05 (2,78)	0.96	<0.01
Univariate tests								
Anxiety		0.03 (1,78)	0.87	<0.01		<0.01 (1,78)	0.95	<0.01
Depression		0.01 (1,78)	0.91	<0.01		0.04 (1,78)	0.84	<0.01

Comparisons based on $n=40$ boys and $n=40$ girls and all tests were two-tailed

As such, the univariate *F* tests are reported but the significance tests are not interpreted. Consistent with results based on the standard scores, the raw score univariate effect sizes were small-to-negligible.

Discussion

Prior research has suggested that children with ASD experience a range of comorbid symptoms. Investigations into sex differences in these symptoms have yielded contradictory results both within and between studies (Solomon et al. 2012). A number of factors may have contributed to the inconsistent findings such as the testing of comorbid symptoms in cognitively-/functionally-heterogeneous and/or broad age-range samples which can mask important sex differences (Mandy et al. 2012; May et al. 2016; Worley and Matson 2011). Significantly fewer females with the diagnosis, especially among those with ASD without ID has also resulted in small female samples in the existing studies (Harrop et al. 2015; May et al. 2016). This study aimed to contribute to the research by testing sex differences in a relatively large sample of girls (ages 6–12 years) specifically with ASD without ID compared to age- and IQ-matched boys with ASD without ID.

To assist with the interpretation of the sex-based comparisons, the externalizing and internalizing symptom levels of the girls and boys in the sample were initially compared to population estimates. Results reflected significantly elevated comorbid symptoms in two of the three externalizing symptom areas (hyperactivity and aggression) and both internalizing areas (anxiety and depression). These findings are largely consistent with results of prior studies of parent-rated externalizing and internalizing symptoms in children with ASD without ID (e.g., Gadow et al. 2005; May et al. 2016; Oswald et al. 2016) including studies using the BASC-2 (Lopata et al. 2010; McDonald et al. 2016; Solomon et al. 2012; Volker et al. 2010). These results continue to suggest increased vulnerability for externalizing and internalizing symptoms, however the elevations were not uniform across the scales. Specifically, the mean Hyperactivity and Depression scores fell in the *at-risk* range, whereas Aggression and Anxiety scores fell in the mid-upper *average* range. Although the normative comparisons suggested vulnerability for these symptoms, the clinical interpretive ranges suggest that the risk might be somewhat greater for hyperactivity and depression symptoms among children with ASD without ID.

The primary purpose of this study was to assess sex differences in parent-rated comorbid symptoms and results revealed similar levels of overall externalizing and internalizing symptoms between girls and boys with ASD without ID in the sample. The lack of overall differences was found for both the standard and raw score comparisons, and was also indicated in the small-to-negligible effect sizes at the individual scale level. This reflects a consistent pattern of similarity in symptom levels for girls and boys in the sample. Interpreting the current findings relative to other studies is a challenge due to a range of methodological differences and/or mixed findings within a given symptom category in other studies (e.g., differences between individual externalizing symptom scales). Despite these challenges, the current findings are consistent with those of Holtmann et al. (2007) and Worley and Matson (2011) who found similar levels of parent-reported aggression and conduct problems in females and males (ranging from 4 to 20 years) with ASD without ID, as well as with May et al. (2014) who reported no sex differences in aggression among 7–12 year olds with ASD without ID. In contrast, May et al. (2014, 2016) found elevated symptoms of hyperactivity in 7–12 year old boys compared to girls with ASD without ID. Although the reason(s) for the differences in results between the current study and May et al. (2014, 2016) are unknown given the similarity in age and functional level of the samples, their studies were conducted with Australian samples and used a hyperactivity measure that more directly tested ADHD symptoms.

Consistent with the larger research base, the current study did not find males with ASD without ID had elevated internalizing symptoms (anxiety and depression) relative to females with ASD without ID. In fact, the current findings are in line with many studies that found no sex differences for children and/or adolescents with ASD without ID (e.g., Holtmann et al. 2007; Kuusikko et al. 2008; Solomon et al. 2012; Worley and Matson 2011). Despite this consistency, two studies found adolescent females exhibited elevations in a specific internalizing symptom (e.g., depression, Oswald et al. 2016; anxiety, Solomon et al. 2012) and May et al. (2014) found elevated social anxiety in girls with ASD without ID compared to boys. Again, some of the differences in results might be a function of differences in study characteristics (e.g., the age of the samples, country of origin of the samples, use of different measures and specificity of the measures [social anxiety], etc.).

Given the methodological strengths and consistent pattern of findings in this study, the results may have some practical implications. One possible implication derives from the finding that the comorbid externalizing and internalizing symptom levels did not differ significantly between girls and boys with ASD without ID in the sample. This suggests that clinicians might not necessarily have to enter the assessment process anticipating different patterns of elevations based on sex. Further, the lack of sex differences should not be misconstrued as a lack of vulnerability for comorbid symptoms for these children. In this study, both girls and boys with ASD without ID showed significantly elevated symptoms of hyperactivity, aggression, anxiety, and depression

when compared to population estimates. This suggests that clinicians, parents, and teachers should be cognizant of the susceptibility to externalizing and internalizing symptoms for many children with ASD without ID (Brereton et al. 2006; May et al. 2014). As such, it may be advisable for clinicians to include a broad screening measure of comorbid symptoms as part of any assessment of children with ASD without ID. Significant elevations in symptoms might then warrant a more in-depth diagnostic assessment to determine the presence of a comorbid diagnosis. In addition to assessment implications, results suggest that supplemental treatment (e.g., cognitive-behavioral, behavioral) might be needed to address the comorbid symptoms (Kuusikko et al. 2008; Oswald et al. 2016). This is often not the primary focus of interventions given the severe impairment caused by the ASD diagnostic symptoms and the need to enhance social functioning; however, these comorbid symptoms can further impair daily functioning and hinder other intervention efforts. Although both girls and boys appeared equally susceptible to comorbid symptoms, it is important to interpret those findings within the context of the sample. Specifically, the lack of sex differences found in this study could be characteristic of this particular sample, which was enrolled in psychosocial treatment studies and/or due to the overall elevated symptoms for this particular sample and therefore might not be representative of the larger ASD population.

The current findings represent an important step in understanding comorbid symptoms specifically in children with ASD without ID. Although this study had several strengths (e.g., relatively large matched sample with ASD without ID, narrow age and cognitive inclusion parameters, testing of sex differences using both standard and raw scores, statistical adjustments to control experiment-wise error, etc.), several limitations warrant mention. A primary limitation involved the characteristics of the sample. While utilizing narrow age (6–12 years) and cognitive inclusion parameters was considered a methodological improvement over prior studies (May et al. 2016; Worley and Matson 2011), those criteria limit the generalizability of the findings to others outside those parameters. The sample was also predominantly Caucasian which further restricts generalizability. This study was also limited by the use of parent raters only. Teacher reports may provide additional insight into potential sex differences in externalizing and internalizing symptoms within structured educational settings. Beyond these, there are limitations inherent in the use of rating scales to assess comorbid symptoms. For example, rating scales are based on parents' perceptions and their ratings may be influenced by potential biases. In addition, rating scales only yield information on symptom levels/severity and are not sufficient for a diagnosis of a comorbid disorder. As such, it is unknown how many of the girls and boys in the sample would have met full criteria for a comorbid diagnosis. It is also important to note that the participants in this study were diagnosed using the DSM-IV-TR which precluded a comorbid diagnosis of ADHD for those with autism (APA 2000). The DSM-V (APA 2013) has removed this restriction and encourages the identification of comorbid diagnoses (including ADHD) when present, and included autism, Asperger's, and PDDNOS under the heading of ASD, which could affect the results and make-up of samples in future comorbidity studies. Another limitation involved the fact that all the children were participants in specific psychosocial treatment studies, which might affect the generalizability of the findings. The study also utilized existing data (retrospective) and future prospective studies may want to use the effects found in this study to inform their sample sizes. Further, although this study had one of the largest samples of girls with ASD without ID, it was nonetheless limited. Considering these limitations, future research should seek to replicate the current findings using larger and more racially/culturally diverse samples. Given the need to study such phenomenon in functionally-homogeneous samples, future research might also examine sex differences in symptoms for younger and/or older youth with ASD without ID. Longitudinal studies will also be useful in documenting sex differences in the developmental trajectory of comorbid symptoms from childhood through adolescence. Finally, studies might benefit from the use of a diagnostic measure to determine the presence of a comorbid diagnosis (not simply symptom levels). It is clear that ongoing studies are needed as comorbid symptoms constitute a significant barrier to daily functioning of youth with ASD without ID.

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Authors Contribution BCN participated in the design, compiled the data, conducted some of the statistical analyses, and drafted the manuscript; CL participated in the study design and interpretation of the data, and drafted the manuscript; JPD participated in the design, led the statistical analyses, and helped to draft the manuscript; JDR coordinated the data compilation and management, and helped to draft the manuscript; and MLT participated in the design and data collection, and drafted the manuscript. All authors read and approved the final manuscript.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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Exploratory factor analysis of the Adapted Skillstreaming Checklist for children with autism spectrum disorder

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Abstract

The Adapted Skillstreaming Checklist measures social/social-communication skills and behavioral flexibility/regulation of children with autism spectrum disorder without intellectual disability. Prior studies provided support for the reliability and criterion-related validity of the Adapted Skillstreaming Checklist total score for these children; however, no studies have examined the Adapted Skillstreaming Checklist factor structure. This exploratory factor analysis examined the factor structure and internal consistency of parent ratings on the Adapted Skillstreaming Checklist for a sample of 331 children, ages 6–12 years, with autism spectrum disorder without intellectual disability. Results yielded a correlated three-factor solution. The individual factors and total score demonstrated very good internal consistency reliability. Findings supported the presence and interpretability of three subscales, as well as derivation of a total composite reflecting overall prosocial and adaptive skills and behaviors. Implications for assessment and research are discussed.

Keywords

Adapted Skillstreaming Checklist, exploratory factor analysis, parent ratings, children with ASD without ID

Significant social/social-communication impairments and circumscribed and repetitive behaviors and interests define autism spectrum disorder (ASD; American Psychiatric Association, 2013). The multi-symptom nature of the disorder, along with significant heterogeneity in symptom expression and functional levels of those diagnosed, poses a major assessment challenge. Factors such as cognitive and language abilities and developmental level influence the manifestation of skills and symptoms and can affect the psychometric properties of measures (Koenig, De Los Reyes, Cicchetti, Scahill, & Klin, 2009; Lord, Corsello, & Grzadzinski, 2014). This suggests the need for development and evaluation of measures for more homogeneous (narrower) subgroups with ASD (Lord et al., 2014). Assessment of clinical features and performance of children with ASD also requires consideration of the manner in which the symptom, skill, and/or behavior is measured. For example, diagnostic observations yield accurate diagnoses; however, they often rely on dichotomous measurement of symptoms (absent or present) which provides little information on the degree to which the skill, symptom, or behavior is exhibited or degree of impairment (Achenbach, 2011; Davis & Carter, 2014).

Rating scales are also used to measure the clinical features and skills of children with ASD (Davis & Carter, 2014; Lopata et al., 2017b). In contrast to diagnostic observations which can be time and labor intensive and require extensive training (Norris & Lecavalier, 2010), rating scales are easily administered, brief, and can assess a range of skills and symptoms based on informants in authentic environments (Constantino & Gruber, 2012; Lord & Corsello, 2005; Norris & Lecavalier, 2010). Continuous scaling of most rating scales is useful as the skills and symptoms of these children are not dichotomous (absent or present) and they exist on a continuum (Ibanez, Stone, & Coonrod, 2014). As such, rating scales can provide important information on the extent, frequency, or severity of the trait (Achenbach, 2011). Continuous scaling is also useful in measuring treatment outcomes (Achenbach, 2011;

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Reynolds & Kamphaus, 2015) including for ASD studies (Constantino & Gruber, 2012). There is widespread recognition of the need for treatment sensitive measures in ASD intervention studies and the negative impact of this issue on efficacy determinations (Bellini, Gardner, & Markoff, 2014; Stichter, Herzog, Owens, & Malugen, 2016; White, Keonig, & Scahill, 2007). Poor alignment of scale items with treatment targets can reduce a scale's sensitivity (Koenig et al., 2009; McMahon, Lerner, & Britton, 2013; Stichter et al., 2016) so developing interventions and scales that are keyed to the clinical features of ASD may improve sensitivity (White et al., 2007). Although researchers have developed study-specific measures to increase treatment sensitivity (e.g. DeRosier, Swick, Davis, McMillen, & Matthews, 2011), few have been rigorously tested for their psychometric properties. This led Lopata et al. (2017b) and White et al. (2007) to recommend that researcher-developed measures be tested for their psychometric properties (and ease of use and cost), especially those that exhibit good treatment sensitivity.

One segment of the ASD population that has increased is children with ASD without intellectual disability (ID); this subgroup currently comprises more than two thirds of those diagnosed (Christensen et al., 2016). The increase in prevalence among this subgroup indicates the need for measures that yield valid information on the skills and clinical features of these children, can be easily completed, and are treatment sensitive (Lopata et al., 2017b; McMahon et al., 2013). Assessing skills and performance on a continuum (continuous scaling) is particularly important for children with ASD without ID as there are few social/social-communication behaviors that are completely absent, which warrants a different type of scale item and assessment approach (Lord et al., 2014). Dichotomous measurement may also be limited as it fails to recognize that skills and symptoms can be observed in contradictory ways. For example, some children may exhibit limited social initiations or interactions, whereas others exhibit excessive, odd, or inappropriate initiations or interactions (Bellini et al., 2014; Davis & Carter, 2014). In addition to social functioning, measures should also assess behavioral performance related to circumscribed and repetitive behaviors and interests as these can interfere with the social and adaptive skills of children with ASD without ID (Bauminger-Zviely, 2014).

The Adapted Skillstreaming Checklist (ASC; Lopata, Thomeer, Volker, Nida, & Lee, 2008) is a rating scale specifically designed to assess the functioning of children with ASD without ID. In contrast to most measures that assess the absence of social-communication skills or behaviors and the presence of unusual interests or behaviors (Lord et al., 2014), the ASC assesses these two dimensions from an adaptive perspective (i.e. prosocial skills and behavioral flexibility and regulation). The ASC was originally developed as a study-specific measure to assess outcomes of a psychosocial treatment for children with ASD without ID, with the treatment targets keyed to the diagnostic elements (social/social-communication skills and circumscribed and repetitive behaviors and interests). Scale items measure prosocial skills and behaviors aligned with the treatment targets and diagnostic features. A number of psychosocial intervention studies for children with ASD without ID have found the ASC to be treatment sensitive (e.g. within-group pre-posttest effect sizes from medium-to-large for parent ratings; Lopata et al., 2017a; Lopata et al., 2008) Sample-specific psychometric data were only presented for two of the interventions studies; these indicated good internal consistency (0.94) and moderate-to-high correlations with related scales on established measures of adaptive and clinical functioning (Lopata et al., 2010; Lopata et al., 2008). Despite the initial support, the data were based on very small samples (i.e. $N=54$ and $N=36$).

Only one psychometric study tested the reliability and validity of ASC parent ratings for a large sample of children with ASD without ID ($N=275$; Lopata et al., 2017b). Internal consistency was very good (0.92) and test–retest reliability was very good at 6 weeks (Pearson $r=0.81$, ICC = 0.78) and good at 9 months (Pearson $r=0.63$, ICC = 0.64). Strong negative correlations were found between the ASC total score and ratings of ASD symptom severity ($r=-0.69$; Constantino & Gruber, 2012). Criterion-related validity was also supported in significant positive correlations between the ASC total and ratings of adaptive skills (including social skills $r=0.64$) and significant negative correlations with ratings of externalizing behavior problems (composite $r=-0.45$) on a broad clinical measure (Reynolds & Kamphaus, 2004, 2015). Based on these positive findings, the authors recommended exploratory factor analyses to assess the possible presence of subscales within the ASC. Given its treatment sensitivity, documenting the ASC factor structure may provide researchers with a more refined measure for testing efficacy.

This study assessed the factor structure of ASC parent ratings for a large sample of children with ASD without ID. It addressed the need for studies of standardized measures used to assess the skills and performance of these children, particularly those used to monitor changes over time or treatment outcomes (Davis & Carter, 2014; McMahon et al., 2013). It also addressed the need for studies of measures that assess skills on a continuous scale and testing for the presence of factors that parallel the primary symptom dimensions (Constantino et al., 2004; Fernandopulle, 2011). Finally, it met the need for studies using a well-characterized but narrowly defined subgroup with ASD (without ID) as cognitive and language abilities can affect a measure's properties including its factor profile (Fernandopulle, 2011; Lord et al., 2014).

Table 1. Demographic characteristics of child sample and parent raters.

Characteristic	Child participants ($N = 331$)
	M (*SD*)
Age (years)	9.31 (1.65)
Parent education (years)	15.66 (2.24)
WISC-IV Short-Form IQ	104.91 (14.38)
CASL	
Short-Form Expressive Language	99.84 (15.92)
Short-Form Receptive Language	105.15 (15.78)
ADI-R	
Impairment in Social Interaction	18.51 (5.33)[a]
Impairment in Communication	15.01 (4.31)[a]
Restricted Repetitive Behavior	5.78 (2.09)[a]
SCQ Total Score	21.54 (5.28)[b]
	n (% of total)
Gender	
Male	294 (88.8)
Female	37 (11.2)
Ethnicity	
White	289 (87.3)
African American	8 (2.4)
Latino	5 (1.5)
Asian American	7 (2.1)
Mixed race/ethnicity	22 (6.6)

WISC-IV: Wechsler Intelligence Scale for Children-4th Edition; CASL: Comprehensive Assessment of Spoken Language; ADI-R: Autism Diagnostic Interview-Revised; SCQ: Social Communication Questionnaire.
The WISC-IV 4-subtest short-form consisted of the Block Design, Similarities, Vocabulary, and Matrix Reasoning subtests and the CASL 4-subtest short-form consisted of the Antonyms, Synonyms, Syntax Construction, and Paragraph Comprehension subtests.
[a]ADI-R scores based on a sample size of $n = 262$.
[b]SCQ Total Score based on a sample size of $n = 69$.

Method

Participants

Parent ratings of 331 children, ages 6–12 years, with ASD without ID were included in the analyses. All children had participated in one of multiple prior trials testing the effectiveness of various psychosocial treatments for this population, and they were recruited for those trials via school and public announcements. Each child had a prior clinical diagnosis of ASD (or autism, Asperger's, or Pervasive Developmental Disorder–Not Otherwise Specified), Wechsler Intelligence Scale for Children–4th Edition (WISC-IV; Wechsler, 2003) short-form IQ > 70, and Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk, 1999) short-form expressive or receptive language score > 70. Each child also met criteria on the Autism Diagnostic Interview–Revised (Rutter, LeCouteur, & Lord, 2003) or Social Communication Questionnaire (Rutter, Bailey, & Lord, 2003) which was completed to confirm her or his diagnosis. The child sample was predominantly male (89%) and White (87%) and had a mean IQ and language level in the average range. Parents reported an average parent education level of 15.7 years (Table 1). Demographic data were compiled from the various treatment trial databases.

Measure

ASC. The ASC (Lopata et al., 2008) is a 38-item rating scale developed to measure the social/social-communication skills and behavioral and interest flexibility and regulation of children with ASD without ID. Each item measures a specific skill or behavior that is keyed to a clinical feature of ASD. As noted, the ASC items assess these skills from a prosocial and adaptive perspective (i.e. extent to which the skill or adaptive behavior is exhibited). Parents rate each item on a scale from 1 (almost never) to 5 (almost always). The ASC includes 30 items (including adapted items) from the Skillstreaming curriculum (Goldstein, McGinnis, Sprafkin, Gershaw, & Klein, 1997; McGinnis & Goldstein, 1997) and 8 researcher-created items. Individual item scores are summed to yield a total composite score, and higher scores indicate greater use of the prosocial and adaptive skill or behavior. (Data on the psychometric properties of the ASC were described in the introduction.)

Procedures

Institutional Review Board (IRB) approval was obtained for each of the treatment trials from which the cases were compiled, along with informed consent and assent (Canisius College IRB). For each treatment trial, parents completed a battery of baseline (pretreatment) measures that included the ASC. Upon completion and return, each protocol was immediately reviewed to ensure it was complete. Incomplete protocols or protocols containing errors (e.g. omitted items, multiple responses to an item, etc.) were immediately reviewed with the parent to correct the error(s). Each treatment trial also instituted a structured scoring and data entry protocol to ensure accuracy. Each ASC was scored independently by two research assistants, with any discrepancies in scoring resolved by a third scorer. Following a similar procedure, all demographic and protocol data were initially entered into the study database by a research assistant and independently checked by a second research assistant, with any discrepancy corrected by a third member of the team.

Data diagnostics and analysis plan

Exploratory factor analysis (EFA) was selected as no prior studies have tested for the presence of factors within the

ASC. This exploratory analytic method is useful in examination of latent constructs in a set of items or measures in the absence of prior theory or research (Floyd & Widaman, 1995). Prior to conducting the EFA, data quality, completeness, and suitability for factor analysis were examined. Complete data were available for all 331 cases, with no out-of-range values. The sample of 331 was considered adequate for EFA based on the study goal of conducting the first structural study of the measure, the homogeneous sample, and preliminary analysis (item analysis and matrix tests including the Kaiser–Meyer–Olkin and Bartlett's tests), as well as guidelines and empirical studies of sample size issues in the factor analysis literature. Individual item analysis was conducted to examine distributions of the items. Skewness, kurtosis, and item-total correlations were examined for all items; the range of skewness values was −0.38 to 0.51 and kurtosis values was −0.70 to 0.41, and the mean item-total correlation was 0.46 with a range of 0.27 to 0.63.

With regard to sample size guidelines for EFA, many recommendations have focused on total sample size or item/participant ratio, which may be set in study planning. However, the quality of the data also affects the quality of the analysis, knowable only once the data are obtained (Bandalos & Finney, 2010). In terms of guidelines, Tinsley and Tinsley (1987) recommended 5–10 participants per item up to samples of 300 (in the present study the ratio was 8.7 participants/item). Comrey (1988) recommended that a sample size of 200 is "reasonably good" (p. 759) for 40 or fewer variables (the present study included 38 with 331 participants). In summarizing the guidelines, DeVellis (2017) concluded that, while not capturing the full complexity of validity issues in factor analysis, the guidelines generally suffice in study planning. Costello and Osborne (2005) reviewed a wide array of guidelines and simulations that went beyond consideration of sample size and item/participant ratios. These simulations illustrated the impact of interactions between communality, sample size, item number, and factorial complexity on the accuracy of reproduced results. Costello and Osborne (2005) concluded that larger communality values in the context of relatively small numbers of factors will improve reproducibility of factor structures. In the present study, initial communality ranged from 0.265 to 0.714 with a mean of 0.450. Costello and Osborne (2005) also emphasized the importance of the exploratory context (not hypothesis testing or confirmatory analysis) in evaluating data for EFA. SPSS 25 (item and reliability analysis, EFA) and Stata 15.1 (parallel analysis) were used in the current analyses.

For the current data set, the Kaiser–Meyer–Olkin measure of sampling adequacy was 0.88, indicating that most of the variance in the data was attributable to underlying factors. Similarly, Bartlett's test of sphericity indicated that the correlation matrix was suitable for structural analysis ($p < 0.001$). Given the goal of identification of latent structure and expectation of correlated factors, principal axis factoring with oblimin rotation was utilized. Following examination of the communalities, scree plot, and eigenvalues, an optimal initial solution was identified. Follow-up analyses examined alternative solutions. Parallel analysis was also used in determining the optimal number of factors. The pattern and structure coefficients were reviewed and reported to facilitate interpretation of the final solution (Bandalos & Finney, 2010).

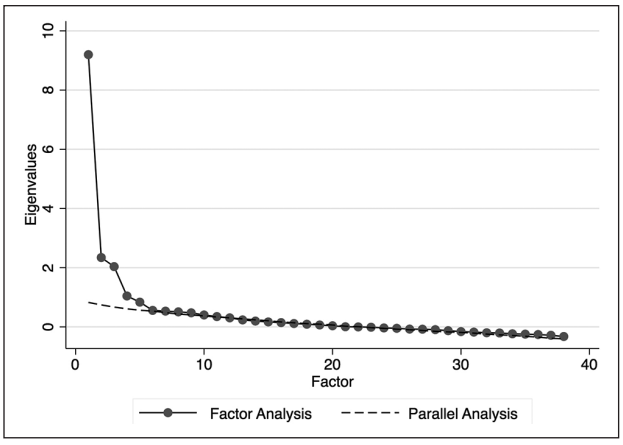

Figure 1. Scree plot with parallel analysis.

Results

The scree plot with results of the parallel analysis is displayed in Figure 1. The break in the eigenvalues appears at approximately 2, following the third factor. The eigenvalues and percent of variance for the first three factors were 9.72 (25.6%), 2.88 (7.6%), and 2.57 (6.8%). The parallel analysis also supports the viability of a three-factor solution, with the parallel eigenvalues well below the first three factors. The next step limited the analysis to three factors, followed by oblimin rotation. The pattern and structure coefficients from this analysis are presented in Table 2. The values in Table 2 further support the three-factor solution as both simple and interpretable. All three factors are represented by substantial numbers of items (19 for Factor 1, 9 for Factor 2, and 10 for Factor 3). The coefficients for each factor are generally moderate, and the pattern and structure coefficients correspond well overall in terms of relative position and at the item level in terms of magnitude. Table 3 presents the factor intercorrelations which are low to moderate (0.20–0.39). Coefficient alpha reliabilities for the three factors are 0.90 (Factor 1), 0.80 (Factor 2), and 0.79 (Factor 3), and 0.92 for the full scale.

The items that comprised the first factor were examined to determine the underlying construct (skill or behavioral feature). Factor 1 was labeled *Social Communication Skills* (SCS) as all 19 items were assessing prosocial interpersonal skills related to social-communication and

Table 2. Factor loadings for exploratory factor analysis of ASC items, principal axis with oblimin rotation.

Item	Pattern coefficients			Structure coefficients		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
5. Does your child let others know that he or she is grateful for favors, etc.?[a]	**0.708**			**0.665**		
22. Does your child show understanding of another person's feelings?[b]	**0.647**			**0.666**	0.347	
25. Does your child let others know that he or she cares about them?[a]	**0.640**			**0.587**		
18. Does your child make verbal or written apologies for things said or done?[b]	**0.640**			**0.605**	0.314	
20. Does your child let others know which emotions he or she is feeling?[a]	**0.637**			**0.649**		
7. Does your child tell others that he or she likes something they have done?[b]	**0.633**			**0.653**		0.330
19. Does your child recognize which emotions he or she has at different times?[a]	**0.616**			**0.631**		
21. Does your child understand what other people are feeling?[a]	**0.610**			**0.669**	0.437	
15. Does your child give assistance to other children who might need or want it?[a]	**0.558**			**0.584**		0.337
32. Does your child express an honest complement to others about how they played a game?[b]	**0.542**			**0.572**		
16. Does your child acknowledge and accept complements from others?[b]	**0.520**			**0.598**		0.347
2. Does your child begin conversations with other people?[a]	**0.513**	−0.374	0.336	**0.543**		0.463
6. Does your child become acquainted with new people on his or her own?[a]	**0.497**	−0.386		**0.506**		0.406
11. Does your child give assistance to adults who might need some assistance?[b]	**0.493**			**0.526**		0.316
14. Does your child take steps to become part of an ongoing activity or group?[a]	**0.451**		0.342	**0.511**		0.464
8. Does your child request assistance when he or she is having difficulty?[a]	**0.422**			**0.468**		
17. Does your child offer to share what he or she has with others?[a]	**0.403**			**0.483**		0.311
4. Does your child know how and when to ask questions of another person?[a]	**0.389**		0.367	**0.533**		0.520
1. Does your child help arrive at a plan that satisfies both him/herself and others who have taken different positions (i.e. negotiates)?[a]	**0.314**			**0.457**	0.378	0.364
29. Does your child stay out of situations that might get him or her in trouble?[a]		**0.622**			**0.636**	
26. Does your child exercise self-control under difficult circumstances?[b]		**0.555**			**0.609**	
30. Does your child accept the consequence of her or his behavior?[b]		**0.506**		0.318	**0.557**	
24. Does your child try to understand someone else's anger without getting angry him/herself?[a]	0.335	**0.457**		0.458	**0.547**	
33. Does your child deal positively with being left out of some activity?[a]		**0.456**			**0.488**	
27. Does your child understand when permission is needed and the right person to ask for it?[b]		**0.435**		0.367	**0.513**	
28. Does your child deal in a constructive way with being teased?[a]		**0.417**			**0.469**	
36. Does your child express her or his thoughts and concerns without complaining or whining?[c]		**0.414**			**0.469**	
23. Does your child express anger without verbal or physical aggression?[b]		**0.334**			**0.369**	
38. Does your child have discussions without running on about a specific topic?[c]			**0.605**			**0.591**
37. Does your child have discussions with others without sharing information that is unrelated to the topic at-hand?[c]			**0.571**			**0.544**

(Continued)

Table 2. (Continued)

Item	Pattern coefficients			Structure coefficients		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
3. Does your child talk to others about things of interest to both of them?[a]			**0.551**	0.369		**0.606**
9. Does your child carry out instructions from others quickly and correctly?[a]			**0.483**		0.318	**0.528**
13. Does your child end conversations before leaving or beginning a new topic?[c]			**0.470**			**0.452**
35. Does your child wait his or her turn to talk (without interrupting)?[c]			**0.460**		0.312	**0.501**
10. Does your child contribute to discussions occurring in the environment?[c]			**0.438**	0.407		**0.520**
34. Does your child maintain eye contact when talking with others?[c]			**0.401**	0.362		**0.483**
1. Does your child listen when you or others talk to him or her?[a]			**0.376**	0.342	0.341	**0.474**
12. Does your child ignore distractions and remain focused on the task at hand?[c]			**0.337**			**0.359**

Highest loadings per factor bolded. Coefficients < 0.30 are not displayed. Items reproduced with permission from Research Press and Lopata and Thomeer.
[a]Exact item from Skillstreaming curriculum (Goldstein, McGinnis, Sprafkin, Gershaw, & Klein, 1997; McGinnis & Goldstein, 1997).
[b]Item adapted from the Skillstreaming curriculum (Goldstein et al., 1997; McGinnis & Goldstein, 1997).
[c]Item created by Lopata and Thomeer (Lopata, Thomeer, Volker, Nida, & Lee, 2008).

Table 3. Factor correlations.

	Factor 1	Factor 2	Factor 3
Factor 1	1.00		
Factor 2	0.27	1.00	
Factor 3	0.39	0.20	1.00

social-cognition (social and emotion understanding and expression, initiating interactions, responding to and interacting with others, etc.). For example, Item 5 strongly loaded on this factor and it focuses on the communication of gratitude toward others. Items 22 and 25 also loaded strongly and describe empathic interaction skills (understanding and expressing emotions). There are eight items with pattern coefficient and seven items with structure coefficient loadings greater than 0.60. The lowest loadings were for Item 31, which assesses negotiation skills (pattern coefficient = 0.314, structure coefficient = 0.457). Overall, Factor 1 (SCS) accounted for approximately 26% of the total variance prior to rotation.

Based on the content of the items, Factor 2 was labeled *Behavior Regulation Skills* (BRS). The nine items on this factor comprise about 8% of the total variance and assess skills involving self-control and avoiding and responding appropriately to challenging situations. The item loading highest on this factor was Item 29 (avoiding trouble situations; pattern coefficient = 0.622, structure coefficient = 0.636) and the highest three items all had loadings that exceeded 0.50 for both pattern and structure coefficients. The item with the lowest loading was Item 23 (expressing anger without aggression; pattern coefficient = 0.334, structure coefficient = 0.369).

After reviewing the content of the items in the third factor, Factor 3 was labeled *Interest Regulation during Discussions* (IRD). The 10 items on this factor accounted for approximately 7% of the variance and they reflect the child's skills in regulating her or his interests during discussions and the manner in which those interfere with social conversations and interactions with others. The highest loading items on this factor (Items 38, 37, and 3) had pattern and structure coefficients above 0.50 and these directly assess skills in refraining from running on about or sharing unrelated information about a circumscribed interest during discussions, and discussing topics of interest to others. The lowest loading item was Item 12 (ignoring distractions and remaining focused; pattern coefficient = 0.337, structure coefficient = 0.359).

With regard to cross-loading, pattern coefficients for Factor 1 included four items with some degree of cross-loading, though all of these coefficients were less than 0.40. The higher loadings of these items on Factor 1, as well as the content of the items, clearly indicate their inclusion on Factor 1 (SCS). Factor 2 had one item that cross-loaded with another factor (Item 24, pattern

coefficient = 0.335); however, that item had a higher loading on Factor 2, and its content was clearly more aligned with the content of Factor 2 items. There were no cross-loading items for Factor 3 in the pattern coefficients. There were more cross-loaded items in the structure coefficients (the correlations of the item with the factor). Although the differences in magnitude of the structural coefficients and content of the individual items clearly supported their inclusion in the primary-assigned factor, the content of the cross-loaded items could be seen to represent overlap with the additional factor or factors. Given the relatively clear factor structure, importance of the items in terms of capturing important ASD-related features, and fact that this was the first test of the ASC factor structure, no items were dropped. Follow-up analyses examining two-, four-, and five-factor models showed that the three-factor model was superior in terms of both interpretability and in producing lower factor correlations.

Finally, because the ASC has been used to monitor treatment outcomes in several psychosocial intervention studies for children with ASD without ID, the relationship between age and each ASC item was examined. To assess the possibility of a correlation between age and each item, distribution statistics and plots were examined. Age was normally distributed (skewness = 0.28, kurtosis = −0.94). Next, 38 scatterplots with regression lines of the individual items with age were examined for evidence of unusual patterns (non-linearity, odd clustering, outliers). These analyses showed no evidence of unusual patterns that might influence correlations. Correlations of each item with age were then calculated. The mean correlation was −0.007 (*SD* = 0.060), median correlation was −0.008, and range was from −0.15 to 0.14. These analyses indicate that age was unrelated to ASC item ratings in these data. Lopata et al. (2017b) also reported no significant association between age and the ASC total score.

Discussion

Children with ASD without ID constitute a majority and increasing proportion of children with ASD. This subgroup is characterized by relative strengths in cognitive and language abilities which can affect both the expression of skills, behaviors, and symptoms and the properties of assessment instruments including its factor profile (Fernandopulle, 2011; Lord et al., 2014). As such, there is a need for development and testing of measures for narrower subgroups with ASD including those without ID. In addition, there is widespread recognition of the need for treatment sensitive measures (e.g. Bellini et al., 2014; Stichter et al., 2016), as well as measures that utilize continuous scaling which yields important information on the degree to which a trait is exhibited and/or responsive to treatment (Achenbach, 2011; Constantino & Gruber, 2012). Continuous scaling is also important as the skills and behaviors of children with ASD without ID exist on a continuum and there are few skills and behaviors that are completely absent (Lord et al., 2014). Given the problems with treatment sensitivity, White et al. (2007) suggested that this might be improved by aligning the measure items and treatment targets to common features of ASD.

The ASC (Lopata et al., 2008) is a rating scale developed to assess the social/social-communication skills and behavior and interest regulation and flexibility of children with ASD without ID. Prior studies provided strong support for the reliability, criterion-related validity, and treatment sensitivity of the ASC for these children; however, no studies were identified that examined its factor structure; this study examined the factor structure and reliability of the ASC for a large sample of children with ASD without ID. Results yielded a three-factor correlated solution. The correlations among the three factors were low-to-moderate supporting the derivation of a composite score reflecting overall prosocial and behavioral skills, in addition to the three separate factor (subscale) scores. Internal consistency estimates were high for the three individual factors (0.79 to 0.90) and total score. Internal consistency for the ASC total score in this study (0.92) is consistent with that reported by Lopata et al. (2017b) for children with ASD without ID.

The largest factor, *Social Communication Skills* (SCS), consisted of 19 items assessing a range of social-communication and social-cognitive skills (e.g. begins conversations, asks questions of another, understands another's feelings, recognizes own emotions). The second factor, *Behavior Regulation Skills* (BRS) consisted of 9 items. This factor was comprised of items measuring behavioral self-control skills such as appropriately responding to teasing, accepting consequences, expressing anger without aggression, dealing appropriately with being left out, and so forth. The third factor, *Interest Regulation during Discussions* (IRD), included 10 items. While many of these items clearly depicted interest regulation skills during conversations (e.g. talking without oversharing, talking about topics of interest to others, remaining on a topic), several items appeared to be related to social skills associated with interest regulation skills. For example, a child's skills in transitioning to a new conversational topic, ignoring distractions, and/or waiting her or his turn to talk would be affected by her or his ability to self-regulate her or his own interest and engage with/follow the interest(s) of others. The correlations among the ASC factors provide some additional support for the link between interest regulation and social competencies as the association was highest between the SCS and IRD factors. This association was also reported by McDonald et al. (2015) who found circumscribed and repetitive interests and behaviors were significantly associated with adaptive social skills. Bauminger-Zviely (2014) similarly noted that restricted

and repetitive interest and behaviors negatively impact social and adaptive functioning.

Overall, results suggest that the ASC items are measuring the skill areas identified by Lopata et al. (2017b, 2008); however, the prior descriptions identified two broad categories (i.e. social/social-communication skills and behavioral and interest regulation). The broad single area of behavioral and interest regulation skills described by Lopata et al. (2017b, 2008) appeared to consist of two factors in the current study, with BRS reflecting appropriate behavioral regulation and responses to negative events and IRD reflecting a separate skill area involving effectively managing intrusive circumscribed interests, especially during discussions, and their associated impact on some social skills.

Despite this being the first study to examine the factor structure of the ASC, the findings may have some clinical implications. For example, the prior intervention studies that used the ASC consisted of cognitive-behavioral treatments targeting social-communication and social-cognitive skills, as well as instructional techniques commonly used for children with ASD without ID in clinical and school settings (i.e. direct instruction, modeling, role-play/rehearsal, and performance feedback; McMahon et al., 2013; Reichow, Steiner, & Volkmar, 2012). Given the increasing use of cognitive-behavioral treatments (Ho, Stephenson, & Carter, 2018) and the common use of these individual instructional techniques in social interventions for children with ASD without ID, the ASC may provide researchers with a treatment-sensitive and psychometrically sound outcome measure. Findings of a correlated three-factor solution might also allow researchers testing interventions to examine treatment effects at a subscale level, as well as the overall ASC composite score. This might help more precisely measure treatment effects on specific areas of prosocial and adaptive functioning associated with ASD. Increased use of the ASC as part of social intervention studies for children with ASD without ID is needed to further assess its treatment sensitivity.

Although this study was the first to provide information on the ASC factor structure and it had a number of strengths (e.g. rigorous screening procedure, relatively large sample of children with ASD without ID, testing of a treatment sensitive measure, etc.), several limitations warrant mention. One limitation involved the relatively homogeneous and narrowly defined group of children in the sample (ASD without ID). While this helped minimize confounding of results (as child IQ, language, and developmental level can affect the properties of a measure), it limits the generalizability to others with ASD outside the inclusion parameters. The sample was also largely White and male, which further restricts the generalizability of findings. The current results were also limited to only parent ratings. Teachers are considered a critical source of information on the skills and symptoms of children with ASD (Norris & Lecavalier, 2010) due to their advanced knowledge of typical and atypical child development and observations of the children in educational settings (Constantino & Gruber, 2012; Mayes & Lockridge, 2018). Furthermore, because schools are the principal settings where psychosocial interventions are provided to these children (Kasari & Smith, 2013), teachers are often used to assess the children's treatment responsiveness. Another limitation involved the fact that neither the current study nor the initial ASC study by the scale developer (Lopata et al., 2017a) conducted or reported any interviewing of the informants' understanding of the items. A final cautionary note appears warranted regarding Item 34 that assesses eye contact during discussions. Although absent or reduced eye contact is a common clinical feature of ASD (APA, 2013), the expectation of eye contact may be culturally oriented toward White Western cultures and not necessarily expected or appropriate in all cultures. Given these limitations, future studies should consider testing the ASC with older and younger youth with ASD without ID, as well as with youth with ASD and ID to assess the potential impact of functional level on the scale's properties. Studies should also seek to test the ASC properties in more racially and ethnically diverse samples, as well as for other informants (e.g. teachers) and clinical groups. In addition, future studies would benefit from interviews to clarify informants' understanding of all the items; this includes studies with ASD and non-ASD samples. Such interviews will provide valuable information on the consistency with which informants interpret the items for children with ASD, as well as possible differences for non-ASD groups. For example, informants for typically developing children or children with other clinical diagnoses may interpret the items on the IRD factor as involving general conversational management skills that are not related to a circumscribed (i.e. special) interest. This may be in contrast to the core circumscribed and repetitive interests captured by informants' ratings of children with ASD without ID.

The current results, along with prior psychometric testing, suggest that the ASC yields reliable and valid information on the skills and behaviors of children with ASD without ID. It also appears to be treatment sensitive to social interventions which are commonly used to develop the social and social-cognitive skills of these children. A unique aspect of the ASC is its assessment of ASD-related features (dimensions) from a prosocial and adaptive perspective using continuous scaling; this yields valuable information on the extent to which the skill or behavior is exhibited, which is important when tracking performance over time. This approach is also considered useful as the skills and behaviors of these children exist on a continuum with few being non-existent. Ongoing testing and replication studies of the ASC are clearly warranted as the field moves toward psychometrically sound measures that can be completed quickly and efficiently and that are cost-effective (Murray, Mayes, & Smith, 2011).

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