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ORIGINAL PAPER

Does Gender Influence Core Deficits in ASD? An Investigation into Social-Communication and Play of Girls and Boys with ASD

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consistently reported as less prevalent in girls on a range of measures (Constantino et al. 2003; Posserud et al. 2009; Ronald et al. 2006, 2005). With regards to core symptomatology, a small base of literature indicates matched abilities in some domains (Andersson et al. 2013; Lord et al. 1982; Van Wijngaarden-Cremers et al. 2013), while others report divergence in symptom presentation (Hartley and Sikora 2009; Kopp and Gillberg 1992; Tsai and Beisler 1983). When looking at individual symptom profiles, girls have been found to demonstrate fewer restricted and repetitive behaviors (RRBs) (Lord et al. 1982; Mandy et al. 2012). They are also less likely to present with externalizing behaviors and accompanying psychopathology issues (Dworzynski et al. 2012; Holtmann et al. 2007; Kirkovski et al. 2013).

Early Social-Communication and Play Behavior

There is substantial evidence in typically developing (TD) children that girls have a developmental advantage in social-communication and play skills relative to boys. In particular girls have an early advantage in behavioral requesting (BR) (Mundy et al. 2007; Olafsen et al. 2006), and in pretend play (Cherney et al. 2003; DiPietro 1981; Jones and Glenn 1991; Liss 1981). However it is unclear how long this gender advantage persists into later development and if such differences are observable in ASD.

Early social-communication impairments [specifically joint attention (JA) and BR] and object play deficits have been extensively reported in ASD (Baron-Cohen 1987; Clifford and Dissanayake 2008; Jarrold et al. 1996; Mundy et al. 1994; Mundy et al. 1986; Naber et al. 2008) and as a result are frequently targeted within intervention (Drew et al. 2002; Kaale et al. 2012; Kasari et al. 2006; Kasari et al. 2010; Kasari et al. 2008; Landa et al. 2011; Oosterling et al. 2010). JA is defined as the ability to shift attention between objects/events and people as a means of sharing and learning about one's world. BR refers to the ability to use non-verbal and verbal behaviors to elicit aid in obtaining objects or events from another person. To date, however, few studies have examined gender differences in these early developing behaviors in children with ASD. Given that these behaviors are some of the very first to flag a child as at risk for ASD, and the fact that boys are identified at a rate of 4–1 to girls, it is possible that girls may not be as impaired in these behaviors as boys, thus accounting for their infrequent and potentially later identification.

Current studies provide a discrepant picture on gender related social-communication skills, but these studies are often limited due to small sample sizes. For example, in two studies girls were found to be inferior in their social-communication abilities relative to boys using the Autism Diagnostic Observation Schedule (Carter et al. 2007; Hartley and Sikora 2009). The sample sizes were 22 girls aged between 18 and 33 months and 42 girls 18–43 months respectively. More recently Andersson et al. (2013) found no differences in diagnostic profiles of girls (N = 20) and boys matched on chronological and developmental age. A recent meta-analysis examining gender differences from toddlerhood through young adulthood found no differences between males and females in their social behavior and communication using a range of measures (Van Wijngaarden-Cremers et al. 2013). In studies that have specifically controlled for IQ, girls and boys appear more similar than dissimilar (Holtmann et al. 2007; Pilowsky et al. 1998; Volkmar et al. 1993).

A handful of studies have explored gender differences in play behavior in ASD. Similar to the literature on typical girls, a few studies find that girls with ASD also show superior symbolic play skills. Knickmeyer et al. (2008) found girls (N = 20) at the age of five had superior pretense play relative to boys with ASD using a play questionnaire. McLennan et al. (1993) found that compared to girls (N = 21), parents of boys reported more impairments in social play. However heightened abilities in girls have not been consistently found (Holtmann et al. 2007; Tsai and Beisler 1983).

Despite the well-reported deficits experienced by children with ASD in the domains of early social-communication and play, there is a discrepant picture of gender profiles of these behaviors in ASD. Most research has examined gender differences in standardized diagnostic, cognitive, and language assessments and has failed to reveal differences between girls and boys with ASD. A more fine-grained analysis of specific behaviors may shed further light on the phenotypic profile of girls with ASD. Thus, the main aim in this study was to determine gender similarities and differences in social-communication and play behaviors in a well-matched and larger sample of children with ASD.

Aims

1. Explore the role of gender on play type and complexity in matched girls and boys with ASD.
2. Explore the role of gender on the specific skills of initiating and responding to JA and BR in matched girls and boys with ASD.
3. Determine if the associations between developmental variables (non-verbal development and language) and social-communication and play abilities differ by gender.

Methods

Ethical approval for this research was obtained through our Institutional Review Board and parents gave written consent for their child to participate.

Participants

Two groups of participants were sampled for this study (Table 1); (1) a group of girls (N = 40) with a clinical diagnosis of ASD and (2) a group of boys (N = 40) with a clinical diagnosis of ASD. Boys were individually matched to a girl with ASD based on study allocation, Autism Diagnostic Observation Schedule Module and algorithm score (ADOS-2; Lord et al. 2012). The ADOS-2 was used to verify the community clinical diagnosis of children upon entry and as a metric of ASD severity for matching purposes (see *Matching Procedure).* The girls represented all female participants recruited to four studies who had play behavior and social-communication data. Play behaviors were gathered through the Structured Play Assessment (SPA; Ungerer and Sigman 1984). Data on JA and BR were gathered using the Early Social Communication Scales (ESCS; Mundy et al. 2003).

Table 1 Sample characteristics

	ASD girls (n = 40)	ASD boys (n = 40)	t	df	*p*
ADOS-2 module (1:2)	32:7 (1 missing)	33:7	–	–	–
ADOS-2 algorithm score	14.50 (4.96)	15.75 (4.61)	1.16	78	.25
Chronological age (months)	40.64 (8.80)	40.05 (9.09)	−.29	78	.77
Developmental quotient	64.27 (21.50)	65.58 (22.42)	.26	78	.79
Non-verbal age equivalent	33.64 (12.03)	32.93 (12.68)	.25	78	.80
Expressive language age equivalent	21.69 (11.09)	22.07 (11.53)	−.15	78	.88
Receptive language age equivalent	22.23 (12.54)	23.35 (12.84)	−.32	78	.75
Ethnicity					
African-American	4	2			
Caucasian	14	16			
Hispanic	6	6			
Asian	7	6			
Other/multi-racial	9	10			

Participant Recruitment and Corresponding Studies

Participants were recruited from four studies at UCLA (Table 2). Study one was a randomized controlled trial (RCT) for children aged between 36 and 48 months with a clinical diagnosis of ASD comparing two different treatment approaches; an in-home parent-mediated intervention targeting symbolic play and JA versus a group treatment approach. Study one was specifically targeting families with low resources. Five girls with ASD recruited were from the UCLA site of the study. Study two was a lab-based RCT for children with a clinical diagnosis of ASD aged between 22 and 36 months. This study compared a parent-mediated intervention targeting symbolic play and JA versus a parent education intervention. Sixteen girls were recruited into study two. Study three was an ongoing school and home based intervention project for children aged between 33 and 54 months of age with minimal expressive language abilities randomized to either a symbolic play and JA intervention or Discrete Trial Training. Six girls were recruited into this study from the UCLA site. Study four was a pre-school based teacher-mediated intervention project with children aged between 36 and 59 months randomized to either immediate or delayed treatment. Thirteen girls were recruited into this study. Play behaviors and social-communication behaviors of JA and BR were coded from entry assessments into each study; therefore our data only explores their behavior pre-randomization and treatment commencement. All children completed the same measures of social-communication (Mundy et al. 2003) and play (Ungerer and Sigman 1984).

Matching Procedure

The ASD boys were individually paired to an ASD girl within the same study sample (1–4) based on the following criteria; (1) same ADOS-2 module at entry (1 or 2); and (2) within one point match on the ADOS-2 algorithm total score. When multiple matches were available, we purposefully selected boys with the closest developmental quotient (DQ) on the Mullen Scales of Early Learning (MSEL; Mullen 1995) and/or chronological age. One girl completed her ADOS-2 with an interpreter present. ADOS-2 data was missing for another girl within the sample who spoke only Spanish and no interpreter was available to administer the assessment in her native language; therefore we matched this participant on MSEL DQ (completed with a Spanish speaking assessor) and chronological age.

Measures

Eligible children were screened using the ADOS-2 upon entry to each of the four studies as a means of confirming community clinical diagnosis of ASD. If children met the cut off for an ASD, they completed the MSEL (to ascertain language and non-verbal development scores) and

Table 2 Sample characteristics by study

	Study 1		Study 2		Study 3		Study 4	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
N	5	5	16	16	6	6	13	13
ADOS-2 module (1:2)	4:1	4:1	15:1	14:1[a]	6:0	6:0	8:5	8:5
ADOS-2 algorithm score	13.80	13.80	15.75	14.94	14.67	13.83	17.00	14.54
Chronological age (months)	37.00	49.60	31.56	31.81	42.50	44.50	50.54	46.75
Developmental quotient	76.46	69.51	64.39	64.81	51.26	58.11	69.46	64.43
MSEL age equivalent	28.40	34.40	20.12	20.92	22.08	25.83	35.23	30.54
Ethnicity								
African-American	1	2	0	0	0	0	1	2
Caucasian	0	0	11	10	0	1	5	4
Hispanic	3	1	1	1	0	0	2	3
Asian	0	1	1	2	4	3	1	1
Other/multi-racial	1	1	3	3	2	2	4	3

[a] One ADOS missing

Table 3 Toys used in the Structured Play Assessment (SPA)

Set	Description	Toys included
1	Shape sorter/ puzzle	Interlocking puzzle
		Stacking cups
		Shape sorter (with 8–10 shapes)
2	Tea set	Dolls (2)
		Cups (2)
		Utensils (5)
		Plate and Knife
		Teapot (with lid)
		Bottle
		Substitution food 'junk items' (2 sponges/ erasers)
3	Grooming	Dolls (2)
		Hairbrush
		Telephone
		Mirror
4	Sleeping	Dolls (2)
		Beds (2)
		Chairs (2)
		Table
		Blanket
		Pillow
		Substitution blanket (tissue or paper)
5	Barn	Dump truck
		Barn (with garage)
		Blocks (10)
		Animals (4)
		Small doll

assessments of play ability (SPA) and social-communication abilities (ESCS). All 80 children completed the SPA and ESCS. (One girl was missing a MSEL due to English not being her first language and no interpreter being present. This was a different participant whose ADOS was completed with an interpreter.)

The Structured Play Assessment (SPA)

The SPA is a 20-minute play interaction with an unfamiliar examiner. The child is presented with five sets of toys that are designed to represent a range of play levels and types whilst sat at a table. The examiner is asked to provide the child with the toys (one set at a time). The examiner may respond to the child's communication; however he or she may not direct the child's play or show the child how to play with the toys. Table 3 reports the toys used within each set. The assessment is video taped and then coded from the video. This measure has been used in a range of studies (Freeman and Kasari 2013; Kasari et al. 2006, 2010; Ungerer and Sigman 1984).

Raters were trained to code the types and frequencies of play behaviors exhibited during the SPA. Play behaviors were drawn from the Developmental Play Assessment (DPA) Instrument Sequence of Categories (Lifter 2000).The DPA calculates the child's play complexity based on their highest spontaneous level attained during the assessment (viewed as a measure of mastery). As we were primarily interested in differences in play behaviors between boys and girls with ASD, we collapsed play into four categories used in previously published studies (Kasari et al.2006, 2010). The four collapsed categories included (a) simple; (b) combination; (c) presymbolic and (d) symbolic play (see Table 4). Discrete play acts were then coded to identify the complexity of the play act (one of four listed above) as well as the frequency of unprompted novel, child-initiated play acts to capture play type. Play types were considered an important variable based on the

Table 4 Play complexity levels (developmental play skills levels)

Level number	Categories	Definition	Corresponding category
1	Indiscriminate actions	All objects treated alike (e.g. mouthing objects)	Simple object
2	Discriminate actions	Differentiates objects, preserving physical and conventional characteristics (e.g. opens doors on barn, plays with hinge on toy phone)	Simple object
3	Take apart combinations	Separate objects (e.g. puzzles pieces out)	Simple object
4	Presentation combinations	Recreates combinations based on their configuration (e.g. nests nesting cups, shapes in shape sorter)	Combination
5	General combinations	Combinations of objects that are simple and nonspecific (e.g. puts puzzle pieces into a nesting cup)	Combination
6	Pretend self	Uses object in a way that indicates a pretend quality (e.g. brings utensil to mouth)	Presymbolic
7	Physical and conventional combinations	Preserves physical characteristics of objects (e.g. stringing of beads) and the unique conventional characteristics in the combination (e.g. places utensils on a plate)	Combination
8	Child as agent	Extends child as agent acts to dolls (e.g. cup to dolls mouth)	Presymbolic
9	Single-scheme sequences	Extends familiar actions to two or more figures or self then doll (e.g. cup to own mouth then cup to doll)	Presymbolic
10	Substitutions	Uses another object to represent another (e.g. block as food)	Symbolic
11	Substitutions without object	Pretends to use something that is not there (e.g. drinks "water" from a cup)	Symbolic
12	Doll as agent	Uses doll as if they are capable of action (e.g. makes doll walk to doll house)	Symbolic
13	Multischeme sequences	Extends different actions to same figure (e.g. feeds dolls, washes doll and then puts to bed)	Symbolic
14	Thematic/fantasy play	Adopts familiar/fantasy roles in a play theme (e.g. Mom or "Superman")	Symbolic

Kasari et al. (2006), Lifter (2000) and Freeman and Kasari (2013)

TD literature that suggests that girls demonstrate greater play diversity in early childhood than boys (e.g., Jones and Glenn 1991).

For each play level (outlined in Table 4), the child receives a score for type and complexity. For example if the child pretends to feed a doll, this is scored as one type (as the act is novel) and one complexity. If the child continues to feed the doll, they receive further scores for complexity, but the type remains at 'one' as the act is no longer novel. If the child stops this play acts and starts to brush the doll's hair this would be scored a separate type (as the act is novel) and one complexity. Only spontaneous unprompted play acts were included. When scoring is complete, the codes are collapsed into percentages of total acts by play level as an index of play complexity (simple, combination, presymbolic and symbolic) and the frequency of novel, child-initiated play types (irrespective of complexity).

Early Social Communication Scales

The ESCS is an assessment designed to elicit verbal and non-verbal communication skills for children with a non-verbal developmental age of between 6 and 30 months (Mundy et al. 2003). An experimenter and the child sit facing one another at a small table. A standardized set of toys (including balloons, wind-up toys, glasses, a hat, comb, book, ball and car) are in view of the child but out of reach. Colorful posters are also placed around the room. The experimenter presents and activates the toys one at a time. The experimenter intermittently points and looks at the wall posters, gives the child simple requests such as "give it to me" and presents the child with opportunities to engage in social games and turn taking. The interaction lasts around 20 min and is videotaped and later scored by independent coders.

In this study we were interested in capturing initiations of joint attention (IJA), initiations of behavioral requests (IBR), responding to joint attention (RJA) and responding to behavioral requests (RBR) (see Table 5). IJA included behaviors such as coordinated looks, giving, pointing and showing. These could occur with or without vocalizations and accompanying eye contact. RJA included responding to the experimenter's JA bids (gaze shift) and is scored as a percentage of correct trials. Initiation of behavioral

Table 5 Description of Early Social Communication Scale Variables

Variable	Description
Initiates joint attention (IJA)	Makes eye contact while using toys; switches gazes between toys and tester; point to toy or distal objects; shows experimenter toy
Responds to joint attention (RJA)	Percentage of correct trials where child turns head and gaze in direction of experimenter's point
Initiates behavioral requesting (IBR)	Makes eye contact when object is out of reach; makes eye contact while reaching; points to inactive toys or objects out of reach; gives inactive toys
Responds to behavioral requesting (IBR)	Percentage of correct trials where child correctly responds to verbal request or gesture

Modified from Mundy et al. (2003)

requesting (IBR) was operationalized as the frequency with which the child uses eye contact, reaching, giving, vocalizations and/or pointing to elicit help from the examiner to activate/obtain objects. Responding to behavioral requesting (RBR) refers to the percentage of correct child responses to the experimenter's requests (e.g., press to give object to examiner) during the administration.

Inter-rater Reliability

Coding reliability was established for both the ESCS and the SPA within study and across the total sample. Intraclass Correlation Coefficients (ICCs) were high for both measures and did not vary between studies. ESCS total ICCs were based on total frequency of IJA ($\alpha = 0.93$), RJA ($\alpha = 0.95$), IBR ($\alpha = 0.96$) and RBR ($\alpha = 0.88$). ICCs for the SPA were calculated based on play complexity and type; Simple (complexity: $\alpha = 0.77$; type: $\alpha = 0.90$), Combination (complexity: $\alpha = 0.93$; type: $\alpha = 0.90$), Presymbolic (complexity: $\alpha = 0.95$; type: $\alpha = 0.97$) and Symbolic (complexity: $\alpha = 0.91$; type: $\alpha = 0.94$).

Statistical Analysis

Statistical analysis was conducted using SPSS 20. Between group differences were explored between the girls and boys for the number of play types (collapsed across play level), percentage of acts by play complexity, IJA, IBR, RJA, and RBR using MANOVAs. Effect sizes were calculated for each of these analyses. In the second stage of the analysis, we conducted correlations within gender to explore the association between our variables of interest and the developmental variables of non-verbal development and language. Language age equivalent scores were established through the receptive and expressive scales of the MSEL. Non-verbal age equivalent scores were comprised of the MSEL fine motor and visual reception scales. If the pattern of correlation was different between girls and boys (i.e., if an correlation was positive in girls, but negative in boys, or if there was a significant correlation with developmental variables in boys, but not in girls) we conducted Z tests to determine if these correlations were significantly different by gender.

We used a Bonferroni-adjusted significance level of 0.007 to account for the seven types of measurement within our data set. These included four variable types from the ESCS (IJA, RJA, IBR, RBR), two from the SPA (overall acts, acts by level) and one from the Mullen (verbal and non-verbal were classified as one measurement type as stem from the same measure and are highly correlated). Tests that passed the Bonferroni adjustment are denoted with an asterisk in the text.

Results

Sample Characteristics

Sample characteristics are reported in Table 1 for the full sample [$n = 80$] and Table 2 by study. ASD girls were matched to ASD boys on ADOS module and score. This score did not differ between the two groups [$t\ (78) = 1.16$, $p = .25$] indicating well-matched pairs. The groups also did not differ on the chronological age [$t\ (78) = -.29$, $p = .77$] or their DQ [$t\ (78) = .26$, $p = .79$]. All variables were matched within each individual study with the exception of chronological age in Study One where the girls were chronologically older than the boys [$t\ (4) = -3.47$, $p < .01$].

Play Type and Complexity by Gender

Number of novel and unprompted play acts was explored between the two groups (girls and boys) using a MANOVA. As shown in Fig. 1, girls displayed more novel play acts during the SPA than boys. However this difference was not significant [$F\ (78,1) = 1.42$; $p = .24$; $\eta^2 = 0.02$]. The percentage of novel acts by complexity (Simple Object, Combination, Presymbolic and Symbolic) was explored in the same way. Again no differences were found between girls and boys [Simple Object: $F\ (78,1) = .10$; $p = .75$; $\eta^2 = 0.001$; Combination: $F\ (78,1) = .06$; $p = .94$; $\eta^2 = 0.001$; Presymbolic: $F\ (78,1) = .07$; $p = .93$; $\eta^2 = 0.001$; Symbolic: $F\ (78,1) = .45$; $p = .50$; $\eta^2 = 0.01$] indicating that play skills were matched in type (novelty) and complexity (Fig. 2).

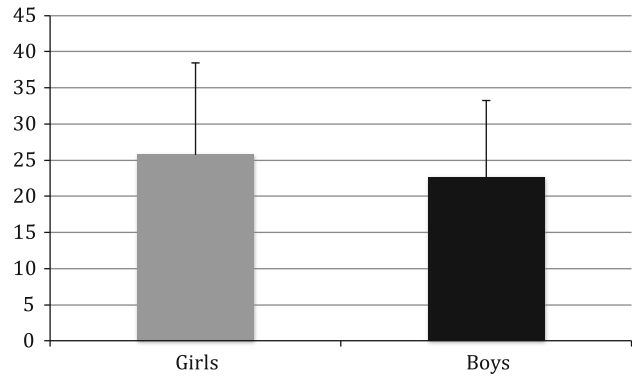

Fig. 1 Frequency of novel play acts (type) by gender

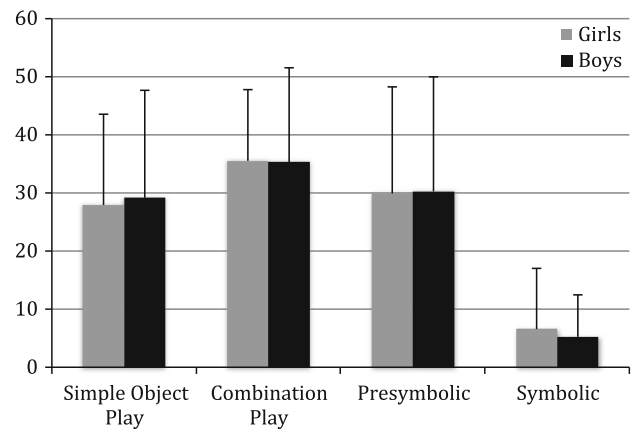

Fig. 2 Percentage of novel play acts by complexity level and gender

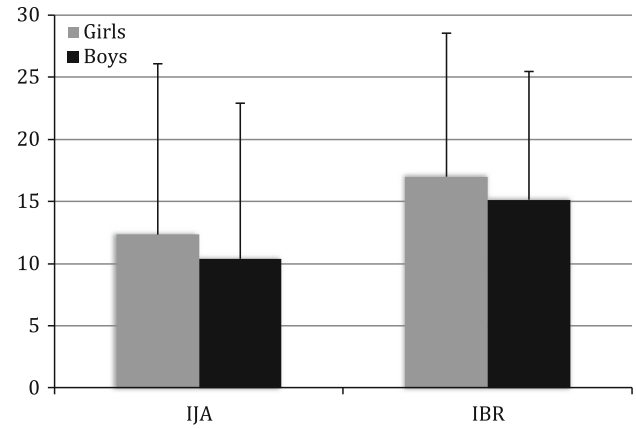

Fig. 3 Frequency of IJA and IBR by gender

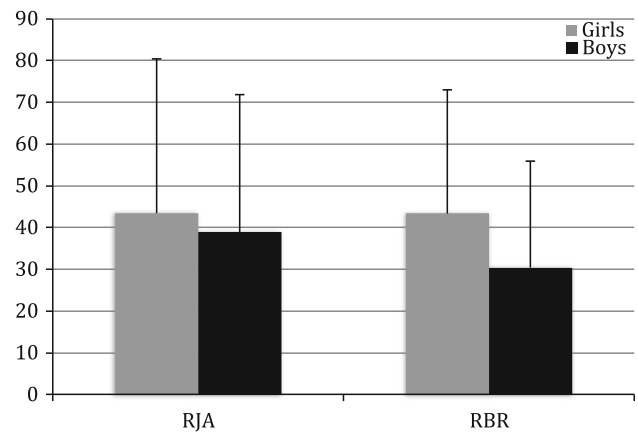

Fig. 4 Percentage of RJA and RBR by gender

Social-Communication by Gender

Joint Attention

Child initiations of and responses to JA were explored. As shown in Fig. 3, girls demonstrated more IJA, however the difference was not significant [IJA: F (78,1) = .44; $p = .61$; $\eta^2 = 0.005$]. In terms of responding to the examiners JA bids, girls again demonstrated a higher percentage of responses than boys (Fig. 4). This difference was not significant [F (78,1) = .23; $p = .63$; $\eta^2 = 0.003$].

Behavioral Requesting

Child initiations of and responses to BR were explored in the same way. As shown in Fig. 3, girls initiated more BR than boys, however again this difference was not significant [F (78,1) = .57; $p = .45$; $\eta^2 = 0.007$]. Girls also responded to the examiners BR bid more than boys (Fig. 4). This difference was not significant [F (78,1) = 3.31; $p = .07$; $\eta^2 = 0.04$].

Associations with Development by Gender

Play Type

Correlations were performed within gender to see if girls and boys non-verbal development or language skills were associated differentially with social-communication and play abilities. For the purpose of retaining power, we did not explore associations with the four individual play complexity levels, focusing on play type (captured through the number of novel play acts) as this has been shown to be different between TD girls and boys previously. Positive associations between girls and boys play type and both non-verbal development [Girls: r (39) = .39; $p = .01$; Boys: r (40) = .41; $p < .01$] and language ability [Girls: r (39) = .69, $p < .01$*; Boys: r (40) = .78, $p < .01$*] were found.

Joint Attention

Non-verbal age equivalents positively associated with IJA abilities in both girls and boys [Girls: r (39) = .35;

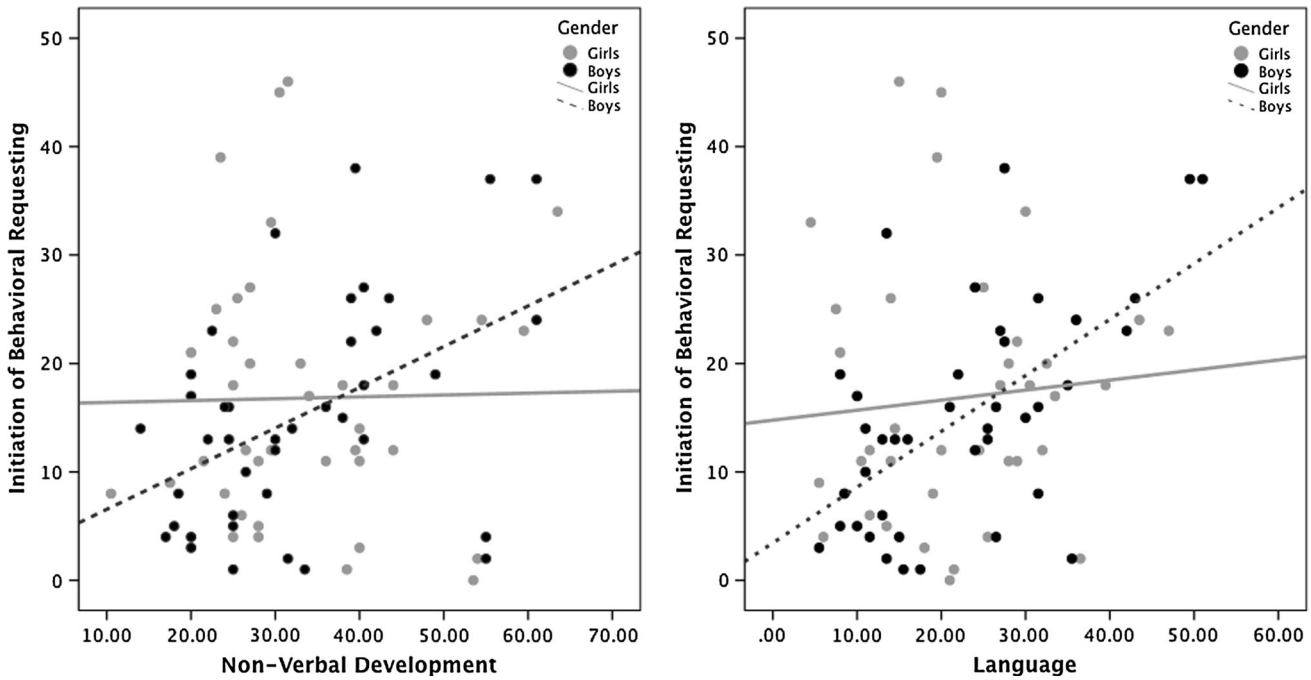

Fig. 5 Initiating behavioral requests—associations with non-verbal development and language by gender

$p = .03$; Boys: r (40) = .38; $p = .01$]. The same was true for language ability and IJA [Girls: r (39) = .51; $p < .01$*; Boys: r (40) = .44; $p < .01$*]. A similar pattern was replicated for RJA abilities. Non-verbal development associated positively with RJA in both girls and boys [Girls: r (39) = .43; $p < .01$*; Boys: r (40) = .68; $p < .01$*], as did language abilities [Girls: r (39) = .58; $p < .01$*; Boys: r (40) = .71; $p < .01$*].

Behavioral Requesting

An interesting pattern of associations by gender was found for BR skills. Non-verbal abilities associated positively with IBR in boys [r (40) = .46; $p < .01$*], however this association was not found in girls [r (39) = .02; $p = .91$]. The difference between these associations (or lack there of for girls) was significant [Z (77) = 2.05, $p = .04$] but did not pass the Bonferroni adjustment. The same pattern was found between language and IBR [Girls: r (39) = .09; $p = .60$; Boys: r (40) = .59; $p < .01$*]. These associations were significantly different from one another [Z (77) = 2.52; $p = .01$] but did not pass the Bonferroni adjustment (Fig. 5).

The reverse pattern was found between RBR and non-verbal development. RBR and non-verbal abilities associated positively in girls [r (39) = .51; $p < .01$*]. This association was not found in the boys [r (40) = .10; $p = .52$]. The pattern of association was different between girls and boys [Z (77) = 1.92; $p = .05$] but did not pass the Bonferroni adjustment (Fig. 6). While the association between language abilities and RBR was stronger in the girls than boys [Girls: r (39) = .61; $p < .01$*; Boys: r (40) = .32; $p = .04$], these correlations were not significantly different [Z (77) = 1.62; $p = .11$].

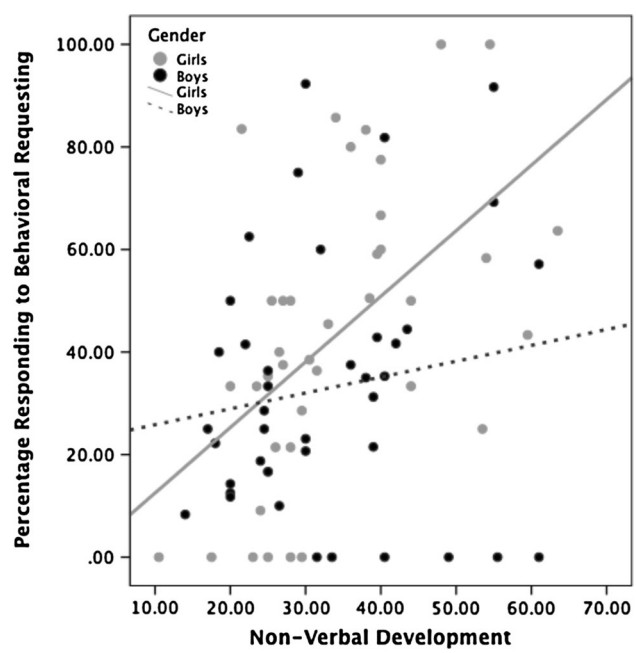

Fig. 6 Responding to behavioral requesting: association with non-verbal development

Discussion

This study represents one of the first attempts to characterize girls and boys with ASD on specific behaviors that constitute core deficits using well-validated behavioral measures of play diversity and social-communication skills. Our aims were twofold; first, we explored potential gender differences in the specific skills of play, JA and BR. Second, we explored whether associations between developmental variables and social-communication and play varied between girls and boys with ASD. Overall, study findings indicate that girls and boys in our sample were more similar than dissimilar, consistent with recent published results with a smaller sample (N = 20) of girls (Andersson et al. 2013). Our results are on a sample double the size of this recent well-matched study and the Knickmeyer et al. (2008) study, which examined play through parental report rather than direct observation.

With regard to play behaviors, we found no gender difference in play type or complexity. This finding is inconsistent with results of studies on girls with ASD that utilized parental report data (Knickmeyer et al. 2008; McLennan et al. 1993) and studies of TD girls (Cherney et al. 2003; DiPietro 1981; Jones and Glenn 1991; Liss 1981). The disparity between parent report data and observational data is unexpected and merits further investigation. A number of possible explanations are postulated as to why we did not find this difference. First, research suggests that parents act as active reinforcers for their child's play behavior and toy choices (Caldera et al. 1989; Eisenberg et al. 1985; Langlois et al. 1980). Parents of a child with ASD may not be as focused on reinforcing *typical* play preferences and behavior given delays in play behaviors experienced by this sample. In turn, given the social impairments experienced by children with ASD, they are likely to be less susceptible to social reinforcement and therefore not display *expected* gender differences in play complexity/diversity. This is the first study to our knowledge to use a behavioral measure designed to study play, rather than rely upon parental report measures or play within the context of a global assessment, such as the ADOS.

An alternative explanation for the failure to replicate differences demonstrated in the literature focusing on TD children has been the *Extreme Male Brain Theory* of ASD (Auyeung et al. 2013; Baron-Cohen 2002) which postulates that girls (and boys) with ASD are *hypermasculinized* in their abilities. Based on this theory, one would predict that typical gender differences might not be present or as strong in ASD.

Similarly, no gender differences were found in IJA or RJA between girls and boys with ASD. Some studies in the literature focusing on TD children have found evidence of early gender differences in these behaviors (Mundy et al. 2007; Olafsen et al. 2006) and one unpublished study reported superior JA abilities in girls with ASD using questionnaire measures (Reavis 2003). However, in our study these abilities appear to be similar in girls and boys with ASD when they are closely matched on developmental and diagnostic variables. This finding is in support of Andersson et al. (2013) and Lord et al. (1982) who found no differences in non-verbal social-communication behaviors between girls and boys with ASD, but differ from studies indicative of greater sharing, directing of attention and overall social-communication abilities in boys with ASD (Carter et al. 2007; Hartley and Sikora 2009; Holtmann et al. 2007; Tsai and Beisler 1983).

While associations with developmental variables were the same for girls and boys for both categories of JA and play diversity, an interesting and diverging pattern of association was found for IBR and RBR with developmental variables. For IBR, associations were found between the frequency of discrete requesting skills and both language and non-verbal development in the boys only. Boys with stronger developmental abilities also demonstrated more frequent IBR skills. This association was not found in girls. The reverse was found between non-verbal development and RBR, with a strong positive correlation in the girls but not in boys suggesting that girls in our sample with more advanced non-verbal abilities were better at responding to the examiners requests. These findings suggest a potential dissociation between the ability to initiate and respond to requests with developmental progress (particularly non-verbal) in both girls and boys with ASD. It is important to note that the difference between associations did not pass the Bonferroni adjusted correction, therefore a larger sample size may be required to further study these potential dissociations between girls and boys.

The variables explored within this study represent behaviors frequently targeted within early intervention for children with ASD (Drew et al. 2002; Kasari et al. 2006; Landa et al. 2011) and associate with later development in skills such as language (Charman 2003; Charman et al. 2000; Kasari et al. 2012). As such these are *pivotal* skills in development, both typical and atypical. Our findings suggest that these skills can be approached similarly in girls and boys with ASD within intervention.

Strengths

This study has a number of strengths; first, only one other study to date has explored gender differences in core deficits in a smaller sample (Andersson et al. 2013). Our study specifically focused on core deficits used within diagnosis and targeted within intervention (Drew et al. 2002; Kasari

et al. 2006, 2010, 2008; Lawton and Kasari 2012; Wong and Kasari 2012). While past research has been inconclusive surrounding gender differences for example in overall symptom severity (Hartley and Sikora 2009; Kirkovski et al. 2013; McLennan et al. 1993; Tsai and Beisler 1983; Van Wijngaarden-Cremers et al. 2013), this study is one of the first attempts to explore specific behaviors known to associate with later outcomes, such as language development, in ASD (Charman 2003; Charman et al. 2000; Kasari et al. 2012, 2008; Markus et al. 2000; Mundy et al. 1990; Toth et al. 2006).

This study is strengthened by the relatively large sample of girls ($N = 40$) compared to previous research. Behavioral research in particular suffers from small sample sizes, large age ranges and unmatched controls. In the case of larger sample sizes, age ranges are variable and methodology reliant upon parent report and more global measures. As discussed by Hartley and Sikora (2009) there may be "subtle but potentially important differences between the male and female ASD phenotype" (p. 1719). While simple and clear between group differences did not emerge in our data, the associations with development variables differed between girls and boys for both the initiation of and response to BR and merits further investigation, particularly as these skills are targeted within intervention.

Limitations

We acknowledge that the absence of a matched TD control group limits the interpretation of our findings. Gender differences in play complexity are relatively well replicated in the TD field (Cherney et al. 2003; DiPietro 1981; Jones and Glenn 1991; Liss 1981) however, we recognize that much of this research is outdated and has not been visited in recent years. Similarly while it is generally assumed girls demonstrate superiority in social-communication skills, research surrounding this is mixed and requires more clarification in TD. As the association between developmental variables, play and social communication in TD girls and boys has not been studied extensively, our ability to understand how our findings fit with typical development is limited. The lack of a matched intellectual disability group also limits our ability to draw firm conclusions as our findings may relate to the developmental delay characteristic of our sample rather than their diagnosis of ASD.

Despite being one of the largest groups of girls with ASD studied behaviorally for core deficits, we recognize that larger sample sizes are required first, in order to replicate our findings and second, for greater statistical power. Larger samples are required in order to explore the complexity of gender differences and the role of gender as a moderator within diagnosis and intervention. Larger sample sizes may also produce statistically significant differences between girls and boys. For example the difference in RBR skills approached significance (with a small effect size) and a larger sample may be required in order to detect subtle differences between boys and girls, such as differential associations with development.

Our study was not a longitudinal study therefore we cannot track development over time, however in this relatively large sample of girls clear patterns emerged with regard to how requesting behaviors may differentially change over time between boys and girls with ASD. While large and well characterized, our samples were significantly delayed relative to their chronological age. Therefore our findings may not be replicated in high functioning children with ASD. There was also considerable variability in our samples in their verbal and non-verbal skills and while there were no differences between girls and boys in these variables, more boys seem to be clustered toward the lower functioning end of our distribution. Thus the differential associations between requesting skills and development may simply reflect an internal characteristic of our data set. In addition to matching on ADOS-2 severity, future research should control for potential differences in the distribution of the data.

Conclusions

Overall girls and boys in our sample were more similar than dissimilar, supporting recent findings in the field (Andersson et al. 2013). Differences in the association between developmental variables and requesting abilities were found between girls and boys, however were not uniform and varied between initiation and responding. While our data are cross sectional, it is to our knowledge one of the largest samples of girls studied behaviorally to data and raises interesting questions about how to approach requesting skills within intervention with girls with ASD.

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