Published in final edited form as:

J Autism Dev Disord. 2009 September ; 39(9): 1298–1304. doi:10.1007/s10803-009-0742-3.

Generativity Abilities Predict Communication Deficits but not Repetitive Behaviors in Autism Spectrum Disorders

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Abstract

Individuals with Autism Spectrum Disorders (ASD) often demonstrate impaired generativity that is thought to mediate repetitive behaviors in autism (Turner in J Child Psychol Psychiatry, 40(6): 839–849, 1999a). The present study evaluated generativity in children with and without ASD via the use-of-objects task (Turner in J Child Psychol Psychiatry, 40(2):189–201, 1999b) and an Animals Fluency Task (Lezak in Neuropsychological assessment. Oxford University Press, Oxford, 1995). Groups differed significantly on two of four metrics from the Animals Fluency Task and two of seven metrics from the Use of Objects task. In the ASD sample, no significant relations were found between generativity and repetitive behaviors. Significant relations were found, however, between performance on the Animals Fluency Task and communication symptoms. Results replicate reports of generativity deficits in ASD and suggest that impaired generativity may reflect communication deficits that are characteristic of the disorder.

Keywords

Autism; Generativity; Repetitive behaviors; Communication; Severity of symptoms; Children

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Introduction

The executive dysfunction theory of autism spectrum disorders (ASD; e.g., Russell 1997; Turner 1999a) suggests that the rigid and invariant behaviors that are characteristic of the disorder may be linked to impaired executive function (EF). However, not all studies have reported executive dysfunction in autism (see Hill 2004; Geurts et al. 2009 for reviews). One potential explanation for these inconsistent findings is that many EF tests are potentially mediated by diverse neurocognitive processes, including those that are not purely executive in nature. For example, classic tests of EF, such as the Wisconsin card sorting (Heaton 1981) and Tower of Hanoi/London (Humes et al. 1997) tests, require planning, working memory, impulse control, inhibition and shifting set, as well as the initiation and monitoring of action (Roberts et al. 1998; Stuss and Knight 2002).

One approach to evaluate the executive dysfunction theory of autism is to employ tasks that tap relatively specific neurocognitive processes. One such process is generativity, which requires respondents to generate spontaneously appropriate novel responses, such as words beginning with a specific letter within a specified period of time (Lezak 1995). Subdomains of generativity include phonological or letter fluency (i.e., generation of words that start with a specific letter), ideational fluency (e.g., generating uses for a specific object) and design fluency (e.g., generation of unique patterns using a grid). Intact generative abilities are a natural precursor to effective rule-governed behaviors, and, as suggested by Turner (1997, 1999a), poor generativity skills may manifest themselves as repetitive behaviors. Therefore, individuals with ASD may repeat certain behavioral patterns because of an inability to generate novel behavioral patterns.

To date, there are a handful of studies that have assessed generativity in ASD. One of the first reports was an early study of perseverative tendencies during a color sequences production task (Frith 1970). More recently, Turner (1999a) reported that individuals with ASD showed reduced generativity for both word and ideational fluency tasks, with strongest results for disallowed and perseverative responses rather than a difference in the quantity of responses. These findings are consistent with reports by the same author (1997) of relatively decreased novel responses and more perseverative responses in a sequencing task by children with autism. Rutherford and Rogers (2003) reported that decreased generativity in 3-year-old children with autism was linked to impaired pretend play behavior with novel toys, despite intact performance on a set-shifting task. Finally, Ambery et al. (2006) reported that individuals with Asperger's disorder showed impaired Controlled Oral Word Association Test (COWA; Benton and Hamsher 1989) scores.

However, results in this area are not entirely consistent. Barnard et al. (2008) examined word and design fluency and found no differences in the autism group relative to learning disabled controls. Additionally, phonological fluency has been found to be both intact (Minshew et al. 1997; Kleinhans et al. 2005) and impaired (Rumsey and Hamburger 1988, 1990) in high-functioning autism relative to both adult controls and adults with severe dyslexia. In typically developing children, findings of relations between fluency and other neurocognitive domains are inconsistent as well: for example, some investigations have found relations with intelligence, while others have not (see Ardila et al. 2000; Arffa 2007 for reviews). For these reasons, we controlled for intelligence in all analyses of relations of generativity abilities and autism symptoms in the present study.

Despite the studies reviewed above, little is known about the potential linkages between generativity profiles and the severity of core autism symptoms. The only study to date to address this question revealed that generativity did not predict repetitive behaviors, but rather predicted communicative abilities (Bishop and Norbury 2005). However, the investigation utilized subscales from the Social Communication Questionnaire (SCQ, Rutter et al. 2003), and only eight items from this 40-item measure tap the symptom domain of repetitive behaviors. Because of the emphasis in the present study on possible relations between generativity and repetitive behaviors, we utilized the Repetitive Behavior Scale-Revised (RBS-R, Bodfish et al. 1999), a measure designed specifically to assess multiple factors of this symptom domain.

In summary, the purpose of the present investigation was to evaluate generativity profiles in a large sample of children with high-functioning autism via the Use-of-Objects (Turner 1999b) and Animal Fluency (Lezak 1995) tasks, and to relate generativity abilities to core autism symptoms. We hypothesized that the ASD group would be characterized by deficits on both generativity tasks, particularly on measures of redundant responses. Additionally, we hypothesized that generativity scores would be correlated with symptoms of restricted repetitive behaviors in individuals with ASD. In particular, we speculated that generativity deficits would predict so-called higher-order repetitive behaviors (e.g., compulsions, rituals/insistence on sameness, and restricted interests) rather than so-called lower-order repetitive behaviors (e.g., motor stereotypies and self-injurious behaviors).

Methods

Participants

Children with ASD were recruited through the University of North Carolina (UNC) Autism Research Registry in conjunction with regional TEACCH (Treatment and Education of Autistic and related Communication-handicapped children) clinics. They received a DSM-IV (American Psychiatric Association 1994) clinical diagnosis of autism, met lifetime criteria for autism or ASD on the Autism Diagnostic Interview-Revised (ADI-R, Lord et al. 1994), and met current criteria for ASD on the Social Responsiveness Scale (SRS; Constantino et al. 2003). Participants in both diagnostic groups did not have a seizure disorder, an acute medical condition, a genetic condition, an uncorrectable visual impairment, or intelligence scores less than 70 on the Leiter International Performance Scale-Revised (Leiter-R; Roid and Miller 1997). All participants and their guardians supplied written informed consent, and the protocol for this study was approved by the UNC-Chapel Hill School of Medicine Biomedical Institutional Review Board.

In an effort to form a sample of ASD cases who demonstrated a range of symptom severities, participants were not recruited based on the presence of specific symptoms (e.g., repetitive behaviors). A total of 65 children with ASD and 43 children who were typically developing were recruited, of whom 50 children with ASD and 42 children who were typically developing met inclusion criteria. Of the 15 who did not meet inclusion criteria, seven scored below the IQ cutoff on the Leiter-R, six scored below the cutoff on the SRS, one did not meet ADI-R criteria, and one was a twin of another participant (a coin flip was used to decide which twin would be excluded from analyses). One child was excluded from the control group because he met the ASD cutoff on the SRS. Generativity data were available from 39 children with ASD (1 female; 30 Caucasian) and 39 children who were typically developing (1 female; 31 Caucasian).

Of the final sample of children with ASD, 13 were taking psychotropic medication (six were taking one medication, five were taking two medications, and two were taking four medications; seven were taking stimulants, two were taking atypical antipsychotics, one was taking a typical antipsychotic, six were taking SSRIs, two were taking non-SSRI antidepressants, one was taking an antiepilectic, four were taking alpha-2 agonists, and one was taking a norepinephrine agonist).

Typically developing children were recruited via mass emails sent to UNC faculty and staff, did not have a history of any psychiatric or developmental disorder, were not taking psychotropic medications, did not have an immediate family member with an ASD diagnosis, and did not score above the ASD cutoff on the SRS.

Measures

Animals Fluency Task (Lezak 1995)—For this measure of generativity, participants were asked to name as many animals as possible within 1 min. If the participant was silent for 15 s, s/he was encouraged to continue trying. Responses were recorded and coded as correct, incorrect (i.e., response was not an animal), or repetitions of a previously named animal. An independent second rater, blind to the participant's diagnosis, scored the responses of 20 participants (10 with and 10 without ASD), and overall agreement was 92.3%.

The Use of Objects task (Turner 1999b)—The procedure described in Turner (1999b) was followed and the same six objects were used (i.e., brick, pencil, mug, 3′ dowel rod, 3′ ribbon, and 32″ elastic). Responses were scored as: (a) incorrect if the use was impossible or did not accomplish a purpose; (b) repetitious if the use was previously given for that object; (c) redundant if the use varied by one element from a previously given use for that or a previous object; and (d) unusual if the use was technically possible but extremely unlikely or odd. All other responses were considered correct. An independent second rater, blind to the participant's diagnosis, scored the responses of 20% of participants, and overall agreement was 83.125%. Discrepancies were resolved through discussion between the two raters.

Cognitive Ability—Nonverbal intelligence was measured with the Leiter International Performance Scale-Revised (Leiter-R; Roid and Miller 1997). A Brief IQ score was obtained based on four subtests of the visualization and reasoning battery (i.e., repeated patterns, sequential order, figure-ground, and form completion).

General Autism Symptom Severity—General autism symptom severity was assessed via the total score of the 40-item Social Communication Questionnaire (SCQ, Rutter et al. 2003), a parental report measure of autism symptomatology. A higher score denotes greater impairment (range 0–40).

Communication Impairments—Communication impairments were measured with the Children's Communication Checklist, 2nd edition (CCC-2; Bishop 1998). This 70-item checklist assesses language structure (e.g., speech, syntax, and semantics) and pragmatic use of language (e.g., initiation, context, and non-verbal communication). To obtain a measure of communication impairment independent of both social deficits and repetitive behaviors, a modified total was obtained by subtracting the 15 items related to social deficits and repetitive behaviors, resulting in a potential range from 0 to 165 (higher scores indicate greater impairment).

Repetitive Behaviors—Repetitive behaviors were assessed via the Repetitive Behavior Scale-Revised (RBS-R, Bodfish et al. 1999). The RBS-R is an informant-based questionnaire that assesses 43 discrete types of repetitive behaviors. We computed the total RBS-R score, as well as the "Ritualistic/Sameness Behavior", "Stereotypic Behavior", "Self-injurious Behavior", "Compulsive Behavior", and "Restricted Interests" sub-scales, as described in Lam and Aman (2007) (higher scores indicate more symptoms).

Results

Table 1 illustrates the demographic and clinical characteristics of both diagnostic groups. Groups were matched on age but not intelligence. Table 2 illustrates mean generativity scores for both groups. Diagnostic group differences in generativity scores were assessed via ANCOVAs that controlled for variance due to nonverbal intelligence.

For the Animal Fluency task, the ASD group reported significantly fewer correct responses ($p < 0.002$) and more incorrect responses ($p < 0.03$). Groups did not differ on the total number of responses ($p > 0.09$) or the number of repetitions ($p > 0.07$). For the Use of Objects task, the ASD group reported fewer total ($p < 0.03$) and correct ($p < 0.03$) responses. Groups did not differ on the number of incorrect responses, the number of repetitions, or the number of unusual responses (p's > 0.16). Within the ASD group, there was no effect of medication status (i.e., on versus off) on any generativity metric (all p's > .10).

To assess potential relations between generativity abilities and autism symptoms, we conducted Pearson partial bivariate correlations between generativity variables and autism symptom scores while controlling for variance due to nonverbal intelligence. Table 3 illustrates the results of these analyses.

As is evident from Table 3, the only significant relations linking generativity and autism symptoms were between communication impairments as assessed via the CCC-2 (exclusive of items assessing social deficits and repetitive behaviors) and two Animal Fluency task scores: the number of responses given ($p < 0.010$) and the number of correct responses ($p < 0.0038$). Scatterplots illustrating relations between the number of correct responses given on the Animal Fluency task and RBS-R total scores and modified CCC-2 scores are depicted in Fig. 1. Contrary to predictions, there were no significant relations between any of the generativity metrics and repetitive behaviors, as assessed via RBS-R subscales (Lam and Aman 2007) and total score (i.e., all other r's < .30 and all other p's > .07).

Discussion

The purpose of the present study was to assess generativity abilities (i.e., the capacity to produce multiple unique and appropriate responses) in a sample of children with ASD and to relate generativity abilities to core autism symptoms. Generativity was assessed with the Animals Fluency Task (Lezak 1995) and the Use of Objects task (Turner 1999b), and primary hypotheses concerned linkages between generativity and symptoms of repetitive behaviors, and higher-order repetitive behaviors in particular.

Results indicated that groups differed on two Animal Fluency task metrics (i.e., number of correct responses and incorrect responses) and two Use of Objects task metrics (i.e., total number given and number of correct responses). This pattern of results represents a replication of prior findings (Frith 1970; Turner 1997, 1999b; Rutherford and Rogers 2003; Ambery et al. 2006; Rumsey and Hamburger 1988, 1990). However, potential linkages between generativity and repetitive behaviors, which would be suggested by Turner's (1997, 1999b) conceptualization that individuals with ASD may repeat certain behavioral patterns because of an inability to generate novel behavioral patterns, were not borne out. Analyses of relations between generativity scores and autism symptoms revealed no associations with RBS-R total or Lam and Aman (2007) subscale scores. In other words, neither the total amount of repetitive behaviors, nor subscales indexing higher-order and lower-order repetitive behaviors, showed evidence of linkages to generativity abilities. Rather, associations were found between the number of responses and the number of correct responses on the Animal Fluency task and communication impairments as assessed via the CCC-2 (exclusive of items assessing social deficits and repetitive behaviors). This pattern of findings replicates Bishop and Norbury (2005) but with a more fine-grained assessment of repetitive behaviors.

We note two important null findings. First, on both generativity tasks, groups did not differ on the number of responses that were repetitions of previous responses. Thus, it would appear that generativity impairments in ASD may reflect a paucity of novel and appropriate responses rather than merely perseverative tendencies that have been observed in other contexts (e.g., Frith 1996). Second, the number of unusual responses given on the Use of Objects Task was not different between diagnostic groups. Individuals with schizophrenia typically report more unusual responses on generativity tasks (Berenbaum and Barch 1995), and given a recent report of the prevalence of bizarre or unusual responses on unstructured tasks in individuals with autism (Solomon et al. 2008), a pattern of unusual responses in the present context would not be surprising. However, it is possible that the measures of unusual generativity that we used may not be sensitive to the disorganized thinking that may be characteristic of ASD. We also note that verbal intelligence was not assessed, and future studies should evaluate whether the observed relations between generativity abilities and communication deficits in ASD may be mediated by verbal intelligence.

In summary, we found that children with ASD showed impaired generativity on an Animal Fluency Task and Use of Objects Task, and detected relations between a subset of generativity abilities and communication abilities, but not repetitive behaviors. These data replicate and extend prior findings and do not support the conceptualization that poor generativity mediates the cognitive and behavioral stereotypies characteristic of autism spectrum disorders. These data suggest the possibility that treatments that improve communication skills in individuals with autism may improve generativity abilities as well, and future studies should assess generativity abilities in a communication treatment context.

Acknowledgments

This research was supported by R01 MH073402 (Bodfish). G. Dichter was supported by NIH/NCRR K12 RR023248 and NIMH K23 MH081285. G. Dichter, K. S. L. Lam, and L. M. Turner-Brown were supported by NICHD T32-HD40127. Assistance for this study was provided by the Subject Registry Core of the UNC Neurodevelopmental Disorders Research Center (P30 HD03110).

References

Ambery FZ, Russell AJ, Perry K, Morris R, Murphy DG. Neuropsychological functioning in adults with Asperger syndrome. Autism. 2006; 10(6):551–564.10.1177/1362361306068507 [PubMed: 17088272]

American Psychiatric Association. Task Force on DSM-1V. Diagnostic and statistical manual of mental disorders: DSM-IV. 4. Washington, DC: 1994.

Ardila A, Pineda D, Rosselli M. Correlation between intelligence test scores and executive function measures. Archives of Clinical Neuropsychology. 2000; 15(1):31–36.10.1016/S0887-6177(98)00159-0 [PubMed: 14590565]

Arffa S. The relationship of intelligence to executive function and non-executive function measures in a sample of average, above average, and gifted youth. Archives of Clinical Neuropsychology. 2007; 22(8):969–978.10.1016/j.acn.2007.08.001 [PubMed: 17920807]

Barnard L, Muldoon K, Hasan R, O'Brien G, Stewart M. Profiling executive dysfunction in adults with autism and comorbid learning disability. Autism. 2008; 12(2):125–141.10.1177/1362361307088486 [PubMed: 18308763]

Benton, AC.; Hamsher, KD. Multilingual aphasia examination. Iowa City, IA: AJA Associates; 1989.

Berenbaum H, Barch D. The categorization of thought disorder. Journal of Psycholinguistic Research. 1995; 24(5):349–376.10.1007/BF02144565 [PubMed: 8551455]

Bishop DV. Development of the children's communication checklist (CCC): A method for assessing qualitative aspects of communicative impairment in children. Journal of Child Psychology and Psychiatry and Allied Disciplines. 1998; 39(6):879–891.10.1017/S0021963098002832

Bishop DV, Norbury CF. Executive functions in children with communication impairments, in relation to autistic symptomatology. 1: Generativity. Autism. 2005; 9(1):7–27.10.1177/1362361305049027 [PubMed: 15618260]

Bodfish, JW.; Symons, FW.; Lewis, MH. The repetitive behavior scale-revised. Western Carolina Center Research Reports; 1999. (unpublished)

Constantino JN, Davis SA, Todd RD, Schindler MK, Gross MM, Brophy SL, et al. Validation of a brief quantitative measure of autistic traits: Comparison of the social responsiveness scale with the autism diagnostic interview-revised. Journal of Autism and Developmental Disorders. 2003; 33(4): 427–433.10.1023/A:1025014929212 [PubMed: 12959421]

Frith U. Studies in pattern detection in normal and autistic children. II. Reproduction and production of color sequences. Journal of Experimental Child Psychology. 1970; 10(1):120–135.10.1016/0022-0965(70)90049-4 [PubMed: 5459646]

Frith U. Cognitive explanations of autism. Acta Paediatrica (Oslo, Norway). 1996; (Supplement):416, 63–68.10.1111/j.1651-2227.1996.tb14280.x

Geurts HM, Corbett B, Solomon M. The paradox of cognitive flexibility in autism. Trends in Cognitive Sciences. 2009; 13(2):74–82.10.1016/j.tics.2008.11.006 [PubMed: 19138551]

Heaton, R. Wisconsin card sorting test manual. Odessa, FL: Psychological Assessment Resources, Inc; 1981.

Hill EL. Executive dysfunction in autism. Trends in Cognitive Sciences. 2004; 8(1):26–32.10.1016/j.tics.2003.11.003 [PubMed: 14697400]

Humes GE, Welsh MC, Retzlaff P, Cookson N. Towers of Hanoi and London: Reliability and validity of two executive function tests. Assessment. 1997; 4:249–257.

Kleinhans N, Akshoomoff N, Delis DC. Executive functions in autism and Asperger's disorder: Flexibility, fluency, and inhibition. Developmental Neuropsychology. 2005; 27(3):379–401.10.1207/s15326942dn2703_5 [PubMed: 15843103]

Lam KS, Aman MG. The Repetitive Behavior Scale-Revised: Independent validation in individuals with autism spectrum disorders. Journal of Autism and Development Disorders. 2007; 37(5):855–866.

Lezak, MD. Neuropsychological assessment. 3. New York: Oxford University Press; 1995.

Lord C, Rutter M, Le Couteur A. Autism diagnostic interview—revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. Journal of Autism and Developmental Disorders. 1994; 24:659–685.10.1007/BF02172145 [PubMed: 7814313]

Minshew NJ, Goldstein G, Siegel DJ. Neuropsychological functioning in autism: Profile of a complex information processing disorder. Journal of the International Neuropsychological Society. 1997; 3:303–316. [PubMed: 9260440]

Roberts, AC.; Robbins, TW.; Weiskrantz, L. The prefrontal cortex: Executive and cognitive functions. Oxford; New York: Oxford University Press; 1998.

Roid, GH.; Miller, LJ. Leiter international performance scale-revised. Woodale, IL: Stoelting Co; 1997.

Rumsey JM, Hamburger SD. Neuropsychological findings in high-functioning men with infantile autism, residual state. Journal of Clinical and Experimental Neuropsychology. 1988; 10(2):201–221.10.1080/01688638808408236 [PubMed: 3350920]

Rumsey JM, Hamburger SD. Neuropsychological divergence of high-level autism and severe dyslexia. Journal of Autism and Developmental Disorders. 1990; 20(2):155–168.10.1007/BF02284715 [PubMed: 2347817]

Russell, J. Autism as an executive disorder. Oxford; New York: Oxford University Press; 1997.

Rutherford MD, Rogers SJ. Cognitive underpinnings of pretend play in autism. Journal of Autism and Developmental Disorders. 2003; 33(3):289–302.10.1023/A:1024406601334 [PubMed: 12908832]

Rutter, M.; Bailey, A.; Lord, C. Social communication questionnaire (SCQ). Los Angeles: Western Psychological Services; 2003.

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Solomon M, Ozonoff S, Carter C, Caplan R. Formal thought disorder and the autism spectrum: Relationship with symptoms, executive control, and anxiety. Journal of Autism and Development Disorders. 2008; 38(8):1474–1484.

Stuss, DT.; Knight, RT. Principles of frontal lobe function. Oxford, New York: Oxford University Press; 2002.

Turner, MA. Towards an executive dysfunction account of repetitive behaviour in autism. In: Russell, J., editor. Autism as an executive disorder. Oxford, New York: Oxford University Press; 1997. p. 57-100.

Turner MA. Annotation: Repetitive behaviour in autism: A review of psychological research. Journal of Child Psychology and Psychiatry and Allied Disciplines. 1999a; 40(6):839–849.10.1111/1469-7610.00502

Turner MA. Generating novel ideas: Fluency performance in high-functioning and learning disabled individuals with autism. Journal of Child Psychology and Psychiatry and Allied Disciplines. 1999b; 40(2):189–201.10.1111/1469-7610.00432

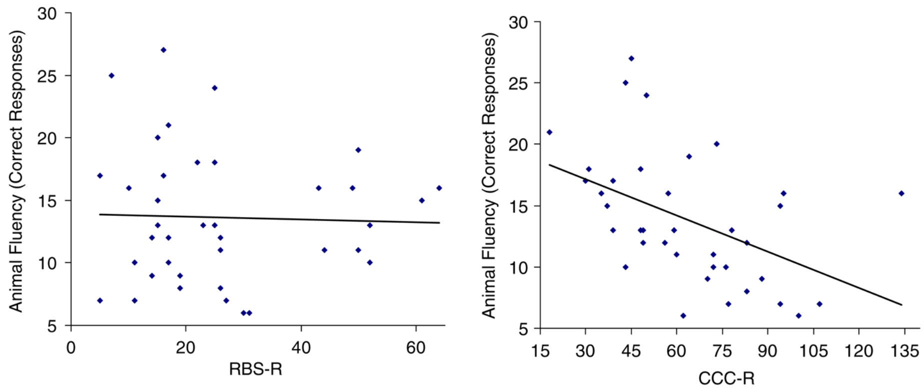

Fig. 1.

Scatterplots depicting the relations between generativity, as indexed via the number of correct responses on the Animals fluency task, and total Repetitive Behavior Scale-Revised (Bodfish et al. 1999) scores (*left*) and Children's Communication Checklist, 2nd edition (CCC-2; Bishop 1998) scores, without the 15 items related to repetitive behaviors (*right*), among participants with autism spectrum disorders

Table 1

Mean (SD) demographic and clinical scores for the autism and control groups and results of *t*-tests assessing for group differences

	Autism (*n* = 39)	Control (*n* = 39)	*t* (*p*)
Age (years)	9.72 (2.66)	10.57 (3.35)	1.24 (0.22)
Leiter-R	101.69 (17.5)	111.67 (16.11)	2.61 (.011)
SCQ[a]	16.49 (3.77)	3.54 (0.35)	18.51 (< 0.0001)
CCC-2[a]	63.73 (25.05)	8 (8.11)	12.91 (< 0.0001)
RBS-R total[a]	25.87 (15.93)	1.74 (2.86)	9.31 (< 0.0001)
RBS-R Sty[a]	5.44 (4.04)	0.15 (0.59)	8.07 (< 0.0001)
RBS-R Sib[a]	2.31 (2.73)	0.10 (0.31)	5.02 (< 0.0001)
RBS-R Comp[a]	3.44 (3.22)	0.021 (0.57)	5.98 (< 0.0001)
RBS-R Ritsam[a]	8.10 (5.99)	0.54 (1.23)	7.73 (< 0.0001)
RBS-R Ri[a]	3.23 (2.25)	0.094 (0.74)	7.63 (< 0.0001)

Significance values are two-tailed and not corrected for multiple comparisons

Note: Leiter-R, Leiter International Performance Scale-Revised (Roid and Miller 1997); SCQ-Soc, Social Communication Questionnaire (SCQ, Rutter et al. 2003); CCC-2, Children's Communication Checklist, 2nd edition (CCC-2-2; Bishop 1998), without the 15 items related to repetitive behaviors; RBS-R total, total score of the Repetitive Behavior Scale-Revised (Bodfish et al. 1999); RBS-R Sty, stereotypic behavior RBS-R factor (see Lam and Aman 2007); RBS-R Sib, self-injurious behavior RBS-R factor (see Lam and Aman 2007); RBS-R Comp, compulsive behavior RBS-R factor (see Lam and Aman 2007); RBS-R RitSam, rituals/sameness RBS-R factor (see Lam and Aman 2007); RBS-R RI, restricted interests RBS-R factor (see Lam and Aman 2007)

[a]Welch–Satterthwaite approximation reported due to heterogeneous group variances

Table 2

Mean (SD) generativity scores for the autism and control groups and results of ANCOVAs testing for a main effect of group, controlling for intelligence as assessed via the Leiter-R (Roid and Miller 1997)

	Autism (n = 39)	Control (n = 39)	$F(p)$
Animal fluency task			
Number given	16.13 (7.30)	19.36 (6.25)	2.89 (0.0932)
Number correct	13.62 (5.26)	18.36 (6.03)	10.66 (0.0017)
Number incorrect	0.44 (0.85)	0.13 (0.34)	5.32 (0.024)
Number of repetitions	2.08 (4.16)	0.97 (1.00)	3.22 (0.077)
Use of objects task			
Number given	31.18 (18.04)	43.03 (22.26)	5.04 (0.028)
Number correct	13.10 (8.48)	18.28 (8.31)	5.68 (0.020)
Number incorrect	5.85 (5.95)	8.92 (7.34)	2.49 (0.1186)
Number of repetitions	1.46 (1.62)	0.95 (1.61)	1.35 (0.2489)
Number of errors	18.08 (12.23)	24.74 (18.99)	2.53 (0.1159)
Number of redundancies	7.72 (4.63)	11.36 (12.16)	3.51 (0.0650)
Number unusual	3.05 (3.15)	3.51 (3.17)	0.02 (0.9014)

Significance values are two-tailed and not corrected for multiple comparisons

Table 3

Pearson bivariate partial correlations (*p* values in parentheses) between generativity variables and measures of autism symptoms among participants with autism spectrum disorders

	SCQ-Soc	CCC-2	RBS-R total	RBS-R Sty	RBS-R Sib	RBS-R Comp	RBS-R RitSam	RBS-R RI
Animals fluency task								
Number given	0.15 (0.37)	**−0.42 (0.010)**	0.072 (0.67)	0.15 (0.37)	0.22 (0.19)	−0.022 (0.89)	0.046 (0.78)	−0.069 (0.68)
Number correct	0.13 (0.43)	**−0.46 (0.0038)**	0.075 (0.66)	0.12 (0.48)	0.28 (0.093)	0.011 (0.95)	0.022 (0.90)	−0.083 (0.62)
Number incorrect	−0.30 (0.07)	−0.13 (0.44)	−0.086 (0.61)	0.14 (0.41)	−0.079 (0.64)	−0.12 (0.43)	−0.13 (0.45)	−0.12 (0.49)
Number of repetitions	0.15 (0.36)	−0.15 (0.38)	0.049 (0.77)	0.080 (0.63)	0.051 (0.76)	−0.023 (0.89)	0.077 (0.65)	0.0076 (0.96)
Use of objects task								
Number given	−0.28 (0.091)	−0.11 (0.52)	−0.043 (0.80)	−0.038 (0.82)	0.025 (0.88)	−0.081 (0.63)	−0.0027 (0.99)	0.023 (0.89)
Number of repetitions	−0.011 (0.95)	−0.076 (0.66)	0.037 (0.83)	−0.025 (0.88)	0.12 (0.49)	−0.14 (0.39)	0.14 (0.39)	0.039 (0.81)
Number of redundancies	−0.13 (0.45)	−0.091 (0.60)	0.0029 (0.99)	−0.038 (0.82)	0.16 (0.33)	−0.026 (0.087)	−0.028 (0.87)	−0.042 (0.80)
Number incorrect	−0.22 (0.18)	0.015 (0.93)	−0.19 (0.26)	−0.20 (0.22)	−0.16 (0.33)	−0.13 (0.44)	−0.091 (0.59)	−0.091 (0.59)
Number unusual	−0.23 (0.17)	−0.16 (0.35)	−0.047 (0.78)	−0.057 (0.74)	0.026 (0.88)	−0.093 (0.58)	−0.069 (0.68)	0.10 (0.55)
Number correct	−0.28 (0.094)	−0.13 (0.46)	−0.049 (0.77)	0.11 (0.51)	0.045 (0.79)	0.0060 (0.97)	0.071 (0.67)	0.023 (0.89)
Number of errors	−0.28 (0.19)	−0.077 (0.66)	−0.097 (0.56)	−0.13 (0.43)	0.0049 (0.98)	−0.12 (0.49)	−0.054 (0.75)	0.018 (0.92)

Note: The sample size for all measure is 39, except the CCC-2, which was administered to 37 participants. Significance values are two-tailed and not corrected for multiple comparisons

Bold values indicate significant ($p < .05$) correlations

SCQ-Soc, Social Communication Questionnaire (SCQ, Rutter et al. 2003); CCC-2, Children’s Communication Checklist, 2nd edition (CCC-2; Bishop 1998), without the 15 items related to repetitive behaviors; RBS-R Total, Total score of the Repetitive Behavior Scale-Revised (Bodfish et al. 1999); RBS-R Sty, stereotypic behavior RBS-R factor (see Lam and Aman 2007); RBS-R Sib, self-injurious behavior RBS-R factor (see Lam and Aman 2007); RBS-R Comp, compulsive behavior RBS-R factor (see Lam and Aman 2007); RBS-R RitSam, rituals/sameness RBS-R factor (see Lam and Aman 2007); RBS-R RI, restricted interests RBS-R factor (see Lam and Aman 2007)