

# Verbal fluency in children with autism spectrum disorders: Clustering and switching strategies

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## Abstract

This study highlights differences in cognitive strategies in children and adolescents with and without autism spectrum disorders ( $n = 52$ ) on a verbal fluency task (naming as many words as possible (e.g. animals) within 60 s). The ability to form clusters of words (e.g. farm animals like “cow–horse–goat”) or to switch between unrelated words (e.g. “snake” and “cat”) was analyzed using a coding method that more stringently differentiates between these strategies. Results indicated that children and adolescents with autism spectrum disorders switched less frequently, but produced slightly larger clusters than the comparison group, resulting in equal numbers of total words produced. The currently used measures of cognitive flexibility suggest atypical, but possibly equally efficient, fluency styles used by individuals with autism spectrum disorders.

## Keywords

autism spectrum disorders, clustering, cognitive flexibility, fluency, switching

Executive functions (EF), a collection of abilities required for executing and controlling effective, purposive, future-oriented behavior in a constantly changing environment, are limited in individuals with autism spectrum disorders (ASDs; Lopez et al., 2005). Within the domain of EF, the ability to generate or initiate responses may be of specific clinical relevance for understanding ASDs, in particular as generativity has been shown to correspond with social communication difficulties, which is a key defining criterion of an autism diagnosis (Dichter et al., 2009; Simek et al., 2010; Turner, 1999). Generating novel responses is often examined using verbal fluency tasks (e.g. Barnard et al., 2008; Beacher et al., 2012; Dunn et al., 1996; Geurts et al., 2004; Spek et al., 2009; Turner, 1999). Fluency tasks examine spontaneous word production under restricted search conditions within a limited amount of time (e.g. naming as many animal names as possible within 1 min). Previous studies have indicated both impaired and adequate performances on verbal fluency tasks in individuals with ASDs (Dunn et al., 1996; Geurts et al., 2004; Turner, 1999). These inconsistent findings may be due to multiple ways and levels of analyses that have been used to examine verbal fluency (Kenworthy et al., 2008). As more research is

recommended (Yerys et al., 2007), we focused on examining the operationalization of verbal fluency in ASDs.

Fluency performance is usually determined by the total number of correct words. Yet, this is a rather crude measure of verbal fluency that does not reveal the use of two interdependent strategies: clustering and switching. Clustering occurs when words are generated within a meaningful subcategory (Turner, 1999). For instance, when asked to name as many animals as possible, one might be inclined to name all the farm animals that come to mind. Clustering may be a reflection of generativity, since this measure specifically depends on the ability to generate responses (Turner, 1999).

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The repetitive and stereotypical patterns of behavior of individuals with ASDs (American Psychiatric Association (APA), 1994) may be related to a tendency to form larger clusters, due to the perseveration on a specific subcategory (e.g. farm animals; Crane et al., 2011). Switching is the ability to shift efficiently to a new subcategory (e.g. pets) when the original subcategory is exhausted or not all the items within the subcategory are recoverable (Troyer et al., 1997; Turner, 1999). Switching is a more active strategy than clustering. It can be considered a product of strategic searching and cognitive flexibility (Hurks et al., 2010). Switching requires flexibility and inhibitory skills, which are limited in ASDs (Hill, 2004; Russo et al., 2007).

A combination of generativity and flexibility likely results in optimal performance on verbal fluency tasks—both in individuals with and without ASDs (Troyer et al., 1997). The overall task score (i.e. number of correct words) will reflect both strategies, in addition to other underlying factors, for example, processing speed. However, they may be used at varying rates by participants with typical development or ASD. Distinguishing between generativity and flexibility strategies might produce a more sensitive measure of fluency. However, empirical findings on individuals with ASDs are mixed, showing evidence for limited switching skills in cognitively able and disabled young adolescents (Turner, 1999), but also indicating similar switching abilities in normally intelligent adults with and without ASDs (Spek et al., 2009). These mixed results may be related to the various ways of measuring fluency outcomes.

In this study, we employed a specific measure of clustering and switching. Spek et al. (2009) and Turner (1999) counted clusters when children reported more than one word in a category (e.g. the combination “horse–cow” would count as one cluster, and receive a score of 1). When children reported a single word, this was coded 0. Importantly, this score was subsequently included in the calculation of the overall number of clusters. Therefore, a child who would report a single word (score 0) and a two-word cluster (score 1) would receive a cluster score of .5. This score would thus be influenced by the single-word score of 0. However, this score of 0 is not a reflection of the ability to form clusters. Using a single word is a skill that is not representative of clustering abilities. Moreover, it is also reflected in the switching scores (i.e. the number of transitions between two clusters). The inclusion of single-word scores in the overall number of clusters thus causes an underestimation of clustering skills. To more directly reflect cluster use, we only computed the mean length of the clusters and did not use the single-word scores in this computation. The switching measure was similar to that of Troyer et al. (1997).

Using this operationalization of semantic verbal fluency, we expected no group differences between children with and without ASDs in the total number of correct words, errors, repetitions, and redundant responses. However, because we used a measure that represents clustering

abilities more directly and is not dependent on the ability to generate single words, we specifically expected fewer switches and larger cluster sizes in children and adolescents with ASDs.

## Method

### Participants

A total of 26 children and adolescents with ASDs participated (23 boys and 3 girls). The ASD diagnoses were based on multiple assessments by an experienced team of qualified psychiatrists and certified psychologists. They used the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*) criteria (APA, 1994), worked independently from the current research group, and were blind to the outcomes of this study. A comparison group, matched for age and verbal ability, included 26 typically developing (TD) children and adolescents (22 boys and 4 girls). According to their parents, none of these TD participants were known to have any psychiatric or neurological disorders. Parents of both ASD and comparison children completed the Dutch version of the Social Responsiveness Scale (SRS, a parental observation scale; Roeyers and Thys, 2010).

Participants in both groups had normal verbal intelligence (>80), as estimated with the Peabody Picture Vocabulary Test (PPVT; Dunn and Dunn, 2004; Schlichting, 2005). The PPVT measures receptive vocabulary and is highly correlated with more general measures of verbal IQ (Hodapp and Gerken, 1999). The first language of all participants was Dutch (see Table 1 for participant details).

### Material and procedure

The *Semantic Verbal Fluency task* (Spreen and Strauss, 1991) is a measure of semantic memory that is also used as a measure of EF. Participants were instructed to name as many animals as possible within a time limit of 60 s. Responses were digitally recorded and transcribed. It was emphasized that subjects should produce as many different words as possible without repeating the same word twice. We calculated three dependent measures for this task: total number of words, proportional cluster size, and relative number of switches.

**Total number of words.** The total number of correctly generated animal names was counted. Animals named in both masculine and feminine forms (“cow–bull”) and an animal and its offspring (“cow–calf”) were counted as one.

**Proportional cluster size.** Following Troyer et al. (1997), semantic clusters were derived from the word patterns generated by the children. Proportional cluster size was calculated by dividing the number of words named in the clusters

**Table 1.** Details of the participants.

	ASD ( <i>n</i> = 26)		Comparison ( <i>n</i> = 26)		<i>t</i> / $\chi^2$	<i>p</i>
	Mean ( <i>SD</i> )	Range	Mean ( <i>SD</i> )	Range		
CA (years;months)	13;8 (6;1)	6;10–23;8	11;8 (5;1)	6;8–19;8	1.29	.204
Gender (boys/girls)	23/3		22/4		.17	.685
SRS	88.3 (5.8)	44–152	28.3 (1.9)	11–46	10.36	.000
PPVT	109 (12.2)	96–145	109 (9.5)	91–131	-.13	.896

ASD: autism spectrum disorder; CA: chronological age; SRS: Social Responsiveness Scale; SD: standard deviation, PPVT: Peabody Picture Vocabulary Test.

by the total number of words produced. Repeated words were eliminated from the total score.

**Relative number of switches.** The relative number of switches was defined by the total number of transitions between two successive clusters (cluster of farm animals → cluster of fish), two successive unclustered words (sheep → shark) or a cluster followed by a single unclustered word (cluster of farm animals → dolphin), divided by the total number of words. Two clusters may also be overlapping, for example, from “farm animals” to “birds” in “cow–pig–chicken–pigeon–eagle.” Here, one switch is made between the cluster “cow–pig–chicken” and “chicken–pigeon–eagle.” All responses were rated for correctness and categorized as clusters or switches. Based on all responses, good agreement was reached between two raters blind to group status (intraclass correlation coefficient = 1.00 for total correct words, .96 for cluster size, and .99 for number of switches).

## Results

Although there were no differences in age between the two groups and age was normally distributed in both groups, the age range of the included groups was rather broad (6–23 years). As verbal fluency performance increases from childhood into adulthood with typical development (Crowe and Prescott, 2003) and gender may impact on verbal fluency (Weiss et al., 2006), we ran the analyses using age and gender as covariates.

As expected, no group differences were found on the total number of correct words (ASD:  $M = 17.36$ , standard deviation ( $SD$ ) = 7.65; TD:  $M = 17.00$ ,  $SD = 6.78$ ), the number of errors, (ASD:  $M = .36$ ,  $SD = .76$ ; TD:  $M = .17$ ,  $SD = .38$ ), repetitions, (ASD:  $M = .32$ ,  $SD = .63$ ; TD:  $M = .58$ ,  $SD = .77$ ), or redundant responses (ASD:  $M = .124$ ,  $SD = 1.42$ ; TD:  $M = 1.13$ ,  $SD = 1.08$ ), on the semantic fluency task. One-way between-group analyses of covariance indicated that children with ASDs,  $M = .40$ ,  $SD = .16$ , made fewer switches than the TD children,  $M = .49$ ,  $SD = .09$ ;  $F_{(1,45)} = 4.19$ ,  $p = .04$ ,  $\eta^2 = .09$  (medium effect size). A trend in the opposite direction showed that the ASD group formed larger cluster sizes,  $M = .23$ ,  $SD = .19$ , than the TD children,  $M = .16$ ,  $SD = .08$ ;  $F_{(1,45)} = 3.77$ ,  $p = .06$ ,  $\eta^2 = .08$  (medium

effect size). While no correlations were found between gender and clustering or switching, age was negatively correlated with cluster length,  $r = -.34$ ,  $p < .04$ , indicating smaller cluster lengths in older participants. This negative correlation was confirmed when both groups were analyzed separately.

Three children with ASDs scored just below clinical threshold on the SRS (although they did show sub-threshold autistic symptoms). Excluding these children from the analyses did not alter the results.

## Discussion

No difference was found in the total number of correct responses on the semantic fluency task between children and adolescents with ASDs and a TD comparison group. This confirmed earlier studies (Dunn et al., 1996; Kleinhans et al., 2005; Minshew et al., 1995). However, when focusing on underlying strategies rather than the total number of correct responses, those with ASDs produced fewer switches and slightly larger clusters compared to TD peers.

Our results contradict Turner (1999), who found that children with ASDs produced fewer words in a cluster than comparison children. However, she used the percentage of correct words in a cluster and scored single words as 0. Importantly, this score of 0 was subsequently included in the calculation of the cluster length. This likely is not a pure measure of clustering ability. We calculated the proportional cluster size by including only clusters with two or more words and disregarding the single words. In our approach, the number of words in the one large cluster determined the proportional cluster size, and the unclustered words had no influence on this. However, similar to Turner (1999), we can conclude that children and adolescents with ASDs seem to use clustering as an efficient strategy to generate an equal number of words. In addition, a special interest in a subcategory of animals (e.g. dinosaurs) may in part explain why some children with ASDs used larger clusters than TD children.

The current results also contradict findings by Spek et al. (2009), who failed to detect any group differences in clustering and switching abilities between adults with and without ASDs. It could be hypothesized that mature

participants with ASDs overcome their limitations in verbal fluency (see also Crowe and Prescott, 2003). The current negative correspondence between age and cluster length is in line with this suggestion. However, longitudinal studies are needed to confirm this suggestion. In addition, our more specific measures of clustering and switching may have contributed to the different outcome. Moreover, the effect of age on both measures was relatively small.

The current results provide interesting perspectives on cognitive flexibility in ASDs. Compared to TD children and adolescents, those with ASDs produced the same number of total correct responses, but created larger clusters, indicating that they retrieve more items from a specific subcategory. It seems that TD children are more likely to switch between subcategories. Clustering is apparently not preferred as much as switching to another subcategory in TD children, but it is a seemingly effective strategy for children with ASDs. The tendency to stay within a cluster may be related to a preference for closed systems (Baron-Cohen et al., 2003). Thus, while restricted and stereotypical patterns of behavior are generally seen as an impairing feature in the functioning of individual with ASDs, it may sometimes be an asset: If they become very good at using a lot of information from a confined source, this may help them compensate for limitations in other domains of functioning, like switching.

These findings could be related to different clustering and switching strategies in ASD and TD children outside of the testing environment. Clustering in ASDs may enable a child to handle the overwhelming amount of incoming information, thus making the world coherent and compensating for an information processing deficit, while switching could amount to increased incoherence. While these assumptions need to be replicated in future studies, they provide leads for compensating strategies in children with ASDs, which could be used in future interventions.

This study is limited by the absence of standardized diagnostic instruments like the Autism Diagnostic Observation Schedule (ADOS) (Lord et al., 2000) and the Autism Diagnostic Interview–Revised (ADI-R) (Lord et al., 1994), information on medication, and additional measures of executive functioning, including alternative measures of switching abilities, which could elucidate the suggested mechanisms more clearly. Furthermore, the findings need to be replicated in a larger sample within a narrower range of age, to further disentangle the cognitive strategies used by people with ASDs. Within these more specific age ranges, fluency may be affected differently in children with ASDs and typical development (Van der Elst et al., 2011). The heterogeneity of ASDs remains an issue that needs further attention. In the *DSM-5* (APA, 2013), the classic ASD subtypes of autistic disorder, Asperger's Syndrome, and pervasive developmental disorder–not otherwise specified (PDD-NOS) are no longer recognized. However, it remains important to correspond our findings

with measures of the severity levels for ASDs, as specified in the *DSM-5*, in particular in the domain of restricted, repetitive behaviors. Future analyses on specific neurocognitive profiles of individuals within the autism spectrum will be necessary to better specify how atypical strategies in fluency inform our theoretical understanding of individuals with ASDs and to improve clinical and therapeutic interventions.

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