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Verbal fluency in adults with high functioning autism or Asperger syndrome

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ABSTRACT

The semantic and phonemic fluency performance of adults with high functioning autism (HFA), Asperger syndrome and a neurotypical control group were compared. All participants were matched for age and verbal ability. Results showed that the participants with HFA were significantly impaired in their performance of both semantic fluency tasks and the phonemic fluency task using the letter M. The Asperger group was only impaired in their performance of the semantic fluency task 'professions'. The social components of the 'professions' task may have influenced the performance of the two disorder groups for this subtest negatively. The fluency deficits could not be attributed to a lack of the use of strategies or to difficulties in switching between strategies. The impairment in two of the three verbal fluency subtests in the HFA group can be attributed to the relatively low processing speed found in this group.

1. Introduction

Executive functioning covers a wide range of skills that are involved in dealing with novel situations. The executive functioning hypothesis offers possible explanations for the various impairments often associated with autism (Rumsey, 1985; Ozonoff, South, & Provencal, 2005). Tasks of verbal fluency are commonly used instruments to assess executive functioning (Henry & Crawford, 2004). Research on fluency functioning in autistic subjects has focussed largely on children and adolescents (Geurts, Verté, Oosterlaan, Roeyers, & Sergeant, 2004; Minshew, Goldstein, Muenz, & Payton, 1992; Turner, 1999; Williams, Moss, Bradshaw, & Rinehart, 2002). Recently, however, clinical practice has been confronted with a growing group of adults that get diagnosed with high functioning autism (HFA) or Asperger syndrome (Gillberg, 1998). Their ability to compensate and camouflage the autistic characteristics throughout their lives led to diagnosis at a relatively old age (Vermeulen, 2002). It is still not clear whether adults with autism spectrum disorders (ASD) and a high level of functioning have overgrown or compensated for the fluency impairments often found in children with ASD. To be able to recommend appropriate treatment, it is necessary to know which impairments and coping mechanisms people with ASD have. It is also important to distinguish between HFA and Asperger syndrome, given the previously found differences in executive functioning between these two groups (for an overview: Klin, McPartland, & Volkmar, 2005). The present article aims to increase the understanding of the impairments in adults with HFA or Asperger syndrome.

1.1. Verbal fluency and underlying mechanisms

Verbal fluency can be described as the ability to generate novel verbal responses (Turner, 1999). Two types of verbal fluency can be distinguished: semantic and phonemic fluency.

In phonemic fluency tasks, words have to be generated starting with a certain letter (Luteijn & Barelds, 2004). In semantic fluency tasks, words have to be generated based on a semantic category, for example 'animals' (Benton, 1968).

In order to examine cognitive mechanisms underlying verbal fluency performance, Troyer, Moscovitch, and Winocur (1997) devised a two-component model. Using the protocols of generated words, they extracted two scores that reflect clustering and switching, respectively. Clustering can be described as the ability to generate words in a certain semantic or phonemic subcategory. Producing words in clusters or subcategories is generally seen as a more efficient way of generating words than a disorganized search. The switching score reflects the ability to switch to a new cluster in order to avoid slowing down (Troyer et al., 1997). Switching abilities and using semantic relationships in order to generate ideas have been found deficient in individuals with autism (Hill, 2004; Ozonoff et al., 2005; Tager-Flusberg, Paul, & Lord, 2005). Along-

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side switching and clustering abilities, the ability to initiate and activate responses was distinguished as a relevant factor in verbal fluency performance (Reverberi, Laiacona, & Capitani, 2006). Individuals who suffer an initiation and activation deficits are slower in processing information and retrieving items in the fluency tasks. Meta-analytic studies in Schizophrenia (Henry & Crawford, 2005b), Huntington's disease (Henry, Crawford, & Philips, 2005) and depression (Henry & Crawford, 2005a) showed, that fluency deficits did not exceed the deficits in speed of processing information in these groups. This suggests that fluency deficits did not qualify as differential deficits relative to processing speed deficits. The speed of processing information has been found impaired in individuals with HFA (Calhoun & Mayes, 2005; Spek, Scholte, & Van Berckelaer-Onnes, 2008).

An analysis of word protocols may reveal whether difficulties in switching, clustering or processing speed are at the base of the verbal fluency performance problems in these groups.

Summarizing the above, research provided evidence that verbal fluency functioning of children and adolescents with HFA is impaired. However, there is still little known about the verbal fluency functioning in individuals with HFA or Asperger syndrome. Differences between HFA and Asperger syndrome in verbal fluency functioning might be expected based on previous research differentiating between the two disorders. Furthermore, not much is known about the underlying mechanisms of verbal fluency performance for individuals with HFA or Asperger syndrome.

1.2. Aims of the present study

The present study will examine whether late diagnosed adults with HFA or Asperger syndrome show impaired functioning in verbal fluency tasks compared to a matched control group of neurotypical individuals. Based on former research among children, we expect that the performance of adults with HFA and Asperger syndrome will be weaker compared to a neurotypical control group. The Asperger syndrome group is expected to show less impairment than the HFA group, since previous studies revealed differences between the two groups in various cognitive areas. To examine the cognitive processes underlying verbal fluency performance, the verbatim reports of the fluency performance will be analyzed to assess switching and clustering abilities. Also the relationship between verbal fluency and processing speed will be examined.

2. Methods

2.1. Procedure

All participants were recruited from GGZ (Mental Health Center) Eindhoven and GGZ Oost-Brabant. The participants visited one of these Mental Health Centers for various reasons. In many cases marital problems or problems at work were the main reason to ask for help. Participants with relevant neurodevelopmental conditions (e.g. ADHD, Tourette syndrome) and genetic conditions were excluded, as were institutionalized patients and patients with a Full Scale IQ below 80. All participants who met the inclusion criteria were asked to participate in the present study. In total, 92 of the 93 possible participants agreed to take part and signed informed consent forms prior to their inclusion in the present study.

In the present study, 31 participants with HFA, 31 participants with Asperger syndrome and 30 neurotypical participants took part. All individuals ranged in age from 18 to 60 years. The mean age of the control group was 39, the mean age of the HFA group was 38, and that of the Asperger syndrome group was 40 (see Table 1). Three quarters of the respondents had a relatively high level of education. The level of achieved education in the three groups is also presented in Table 1. The present study was approved by the Ethics Committees of both centers. The neurotypical control subjects were recruited from the general population. Healthy controls were not included in the present study if they had a history of psychiatric illness or if autism ran in the family.

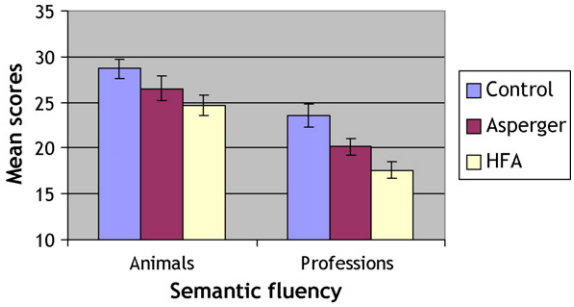

Fig. 1. Mean semantic fluency scores of the control group, the Asperger group and the HFA group. Error bars denote the 95% confidence intervals.

2.2. Assessment of disorder

The diagnosis of either HFA or Asperger syndrome was established through evaluation of history and current symptomatology. To gather developmental information, parents or an older brother or sister were interviewed using the Dutch version of the Autistic Disorder Diagnostic Interview, revised version (ADI-R, Lord, Rutter & Le Couteur, 1994). The ADI-R was administered by psychologists who were officially trained in the administration and scoring of this instrument. The ADI-R has excellent reliability and validity when used by trained examiners (Lord, Rutter, & Le Couteur, 1994).

To gather information of current symptomatology, a semi-structured interview was administrated. This interview assessed the DSM-IV-TR criteria of the autistic disorder and Asperger syndrome by asking the participant standard questions (APA, 2000). Because of the controversial nature of the DSM-IV criteria in differentiating between the two disorders (Ghaziuddin, Tsai, & Ghaziuddin, 1992; Mayes, Calhoun, & Crites, 2001), additional questions were used, based on the diagnostic criteria of Gillberg & Gillberg (1989) and ICD-10 (WHO, 1993).

2.3. Assessment of intelligence

The intelligence profile was assessed using the Dutch version of the WAIS-III (Wechsler, 2000). Compared to WAIS-II, significant modifications and structural changes have been made. The WAIS-III has a new factor structure that gives the best representation of the factors underlying intelligence (Arnau & Thompson, 2000; Ryan & Paolo, 2001). WAIS-III has excellent psychometric properties (Sattler & Ryan, 1999) and has been validated for the Dutch population (Wechsler, 2000).

2.4. Assessment of semantic and phonemic fluency

The semantic fluency tasks used in the present study were subtasks of the Groninger Intelligentie Test (GIT, Luteijn & Barelds, 2004). Participants were asked to name as many animals, and in the second task professions, as possible within 1 min. The phonemic fluency task used in the present study was originally designed by Benton (1968), using the letters F, A, and S. It was adapted for use in Dutch and Flemish populations by Verté, Geurts, Roeyers, Oosterlaan, and Sergeant (2006) using the letters K and M. The participants were asked to name as many words as possible starting with the letter K, and in the second task with the letter M, within 1 min. Subjects were instructed not to use people's names or repetitions of the same word with different endings (e.g. *power*, *power*boat, *power*plant, etc.). When a certain word was repeated within a task, this response was eliminated from the total score (Figs. 1 and 2).

Table 1
Matching variables.

	Autism	Asperger	Control	Statistic	*p*-Value
Gender (male:female)	31 (28:3)	31 (29:2)	30 (28:2)	$\chi^2 = 0.286$	.87
Education (L/M:H)[a]	31 (9:22)	31 (10:21)	30 (6:24)	$\chi^2 = 1.239$	.54
Mean age	38.58 (11.75)	40.75 (10.95)	39.89 (11.45)	$t(91) = 0.285$	.75
VCI[b]	111.81 (9.65)	114.84 (9.51)	116.77 (11.33)	$t(91) = 1.845$	.16

[a] Educational level L/M:H, lower/middle versus higher.
[b] VCI, verbal comprehension index as measured by the WAIS-III.

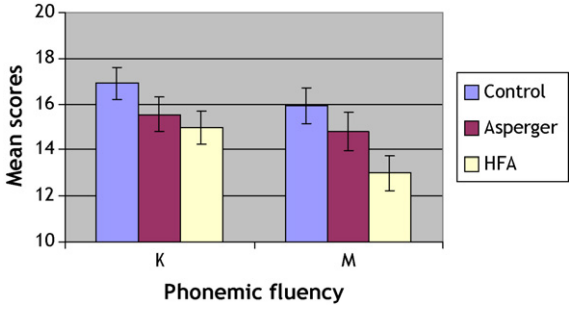

Fig. 2. Mean phonemic fluency scores of the control group, the Asperger group and the HFA group. Error bars denote the 95% confidence intervals.

2.5. Analysis of mechanisms underlying semantic and phonemic fluency

To explore the underlying mechanisms of verbal fluency, the number of switches and clusters was quantified using the two-component model of Troyer et al. (1997) and modifications of this model by Reverberi et al. (2006). In semantic fluency, clusters were defined as groups of successively generated words that belong to the same semantic subcategory. The determination of subcategories of animals was based on the results of the study of Troyer et al. (1997). The subcategories for professions were derived from the actual patterns of words generated by a neurotypical group of participants. Two independent raters derived subcategories out of the word protocols. Only the subcategories named by both raters were used in the present study.

Clusters in phonemic fluency were defined as groups of successively generated words that start with the same two letters, words that differed only by a vowel sound, or words that rhymed or were homonyms. The following scores were extracted from the word protocols, using the guidelines of Troyer et al. (1997) and Reverberi et al. (2006):

1. *The relative number of repeated words*. This variable represents the percentage of the total number of produced words that were repetitions of a word that was already named.
2. *The mean cluster size*. This represents the total number of words named in the clusters, divided by the number of clusters generated. The size of each cluster was counted starting with the second word of the cluster. For example: two words had a cluster size of 1 (see Troyer et al., 1997).
3. *The relative number of switches*. This variable consists of the number of switches divided by the total number of words generated including repetitions, minus 1 (see Reverberi et al., 2006).

2.6. Matching procedure

Fluency performance is highly correlated with verbal abilities in the general population (Crawford, Moore, & Cameron, 1992; Crawford, Obonsawin & Bremner, 1993; Miller, 1984). To prevent that fluency performance differences in the present study can be attributed to differences in verbal ability, the three groups were matched for performance on the WAIS-III factor scale 'Verbal Comprehension Index' (VCI). Those participants with a VCI-score of 95 or above were selected for the present study to ensure normal to high level of functioning. Further, the three groups were matched according to age, gender distribution and educational level because these factors have also been proven to influence verbal fluency performance (Henry & Crawford, 2004; Van der Elst, Van Boxtel, Van Breukelen, & Jolles, 2006). A Chi-square test illustrated that the three groups did not differ in gender distribution ($\chi^2(2) = .286$, $p = .87$) or level of education ($\chi^2(2) = 1.239$, $p = .54$) and a one-way analysis of variance (ANOVA) showed that the three groups were comparable in VCI ($F(2,89) = 1.845$, $p = .16$) and age ($F(2,89) = .285$, $p = .75$). The characteristics of the subjects in the three groups are presented in Table 1.

Table 2
Semantic and phonemic fluency differences in the diagnostic groups.

	M	S.D.	*M*	S.D.	*n*
Semantic fluency					
	Animals		Professions		
HFA	24.71	6.26	17.55	5.10	31
Asperger	26.52	7.23	20.16	5.22	31
Control group	28.70	5.71	23.57	6.64	30
Phonemic fluency					
	K		M		
HFA	14.97	4.17	13.00	4.22	31
Asperger	15.55	4.11	14.81	4.59	31
Control group	16.90	3.86	15.93	4.36	30

Qualitative data collection in a clinical setting had practical constraints, since it is time-consuming. Therefore, only three groups of 14 participants were included into the qualitative analyses of the word protocols to determine the clustering and switching abilities according to the two-component model of Troyer et al. (1997) and modifications by Reverberi et al. (2006). These qualitative analyses can be regarded as a pilot experiment to assess whether qualitative features might be present in larger groups. In each of the three groups, 14 participants were randomly selected for this analysis of switching abilities. *T*-tests and χ^2-analysis showed that the three subgroups were comparable in VCI, mean age, and gender distribution. All generated words were scored by the first author and by an independent rater. Inter-rater reliabilities, calculated by using Pearson correlation coefficients, were high for cluster size ($r = .99$, $n = 42$, $p = .00$) and for number of switches ($r = .99$, $n = 42$, $p = .00$).

3. Results

3.1. Differences in verbal fluency between the three groups

Verbal fluency scores for the HFA group, the Asperger syndrome group and the control group were studied by means of a one-way between-group multivariate analysis of variance (MANOVA). The results showed that the main effect of diagnosis was statistically significant ($F(8,172) = 2.34$, $p = .02$, partial eta squared = .10). The effect size can be interpreted as moderate according to the criteria of Cohen (1988). When the results for the dependent variables were considered separately, two of four verbal fluency scores were statistical significant: professions ($F(2,89) = 8.58$, $p < .01$, partial eta squared = .16) and the letter M ($F(2,89) = 3.47$, $p = .03$, partial eta squared = .07). The effect sizes reflect a large effect for professions and a moderate effect for the letter M, according to Cohen (1988). A trend towards an effect was found for animals ($F(2,89) = 2.93$, $p = .06$, partial eta squared = .06), with an effect size that can be interpreted as moderate (Cohen, 1988). Analysis of the letter K yielded no significant results ($F(2,89) = 1.82$, $p = .16$, partial eta squared = .04). To investigate which differences between the three diagnostic groups added to the main effects, post hoc Tukey comparisons were performed. The means and standard deviations of the various groups are presented in Table 2.

Analysis showed that the control group named more words in all verbal fluency tasks compared to the individuals with HFA or Asperger syndrome. The differences between the HFA and the control group in both semantic fluency tasks (animals: $p = .04$, professions $p < .01$) and the phonemic fluency task using the letter M ($p = .02$) were significant. The difference between the control group and the Asperger syndrome group was significant only for the semantic fluency task using professions ($p = .05$). Differences between HFA and Asperger syndrome were not significant for any of the fluency tasks. No interaction effects were found between the two phonemic fluency tasks and the research group being either HFA or neurotypical ($p = .30$, partial eta squared = .02). Further, analysis showed no interaction effects between the two semantic fluency tasks and HFA versus the neurotypical group ($p = .15$, partial eta squared = .04). Figs. 1 and 2 illustrate the mean semantic and phonemic fluency scores for the three groups.

3.2. Processing speed in the three groups

The differences in processing speed between the three groups were analyzed by means of a one-way between-groups analysis of variance. The assumptions of homogeneity were met.

The mean score of the neurotypical group ($M = 112.2$, S.D. = 14.0) was higher than the mean scores of the Asperger syndrome group ($M = 108.9$, S.D. = 17.2) and the HFA group ($M = 99.8$, S.D. = 21.3). A significant main effect of diagnosis on processing speed was found ($F(2,89) = 4.01$, $p = .02$). Post hoc Tuckey comparisons showed that processing speed ($p = .02$) was significantly lower among the HFA subjects compared to the neurotypical subjects. The effect size can be described as moderate according to criteria of Cohen (1988)

Table 3
Qualitative analysis semantic fluency.

Variable	Controls	Asperger	HFA	Sig
Relative number repeated words	0.00 (.00)	0.01 (.02)	0.00 (.01)	0.53
Mean cluster size	2.60 (1.70)	2.29 (1.02)	2.22 (1.60)	0.77
Relative number of switches	0.94 (.30)	0.97 (.21)	1.02 (.28)	0.70

Table 4
Qualitative analysis phonemic fluency.

Variable	Controls	Asperger	HFA	Sig
Relative number repeated words	0.01 (.02)	0.01 (.01)	0.02 (.03)	0.30
Mean cluster size	0.97 (1.05)	0.84 (.50)	0.94 (.57)	0.89
Relative number of switches	1.44 (.35)	1.42 (.23)	1.42 (.23)	0.99

(partial eta squared = .08). No differences appeared between the HFA and the Asperger syndrome group or between the Asperger syndrome and the neurotypical group.

3.3. The relationship between verbal fluency performance and processing speed

A one-way between-groups analysis of covariance was conducted to investigate whether the differences in verbal fluency between the three groups can be attributed to performance speed differences. After adjusting for the performance speed scores, there were no significant differences between the neurotypical and the HFA group on the semantic fluency task using animals (F (2,88) = 1.14, p = .32, partial eta squared = .03) or on the phonemic fluency task using the letter M (F (2,88) = 1.32, p = .27, partial eta squared = .03). The semantic fluency differences on the task using professions remained significant after adjusting for performance speed scores (F (2,88) = 6.23, p < .01, partial eta squared = .12).

3.4. The use of clustering and switching in the three diagnostic groups

In the three diagnostic groups word protocols were analyzed to determine the relative number of repeated words, the mean cluster size and the relative number of switches.

Table 3 presents the results for semantic fluency, Table 4 for phonemic fluency.

To trace possible differences between the three diagnostic groups, between-group analyses of variance were done with semantic fluency, respectively, phonemic fluency as the dependent variables. The assumptions of homogeneity and equality of variance were met. Therefore Wilks' λ was used to measure group differences. No differences between the three groups were found in the relative number of repeated words, mean cluster size or relative number of switches. No main effect of diagnosis was also found when the findings for the semantic and phonemic fluency were combined (F (24,56) = .096, p = .53). These findings suggest that no differences in switching and clustering abilities exist between the three diagnostic groups.

4. Discussion

4.1. Differences in verbal fluency between the three groups

The present study compared verbal fluency performance in adults with HFA, Asperger syndrome and a matched neurotypical control group. The participants with HFA were impaired in their performance of semantic and phonemic fluency, in comparison to the neurotypical group. No significant differences appeared between the HFA and the Asperger syndrome group. The Asperger syndrome group exhibited impaired functioning in the semantic fluency task 'professions' compared to the neurotypical control group.

The verbal fluency impairment found in the HFA group of this study replicates for adults what Geurts et al. (2004) and Turner (1999) found for children with HFA. The participants with HFA had an average verbal comprehension index (VCI) of 112, which is defined by the WAIS-III scoring manual as above average ability (Wechsler, 2000). Since all groups were matched for VCI and age, differences in verbal fluency cannot be attributed to verbal abilities or age. Our findings thus suggest a broadly based deficit in verbal fluency in individuals with HFA at all levels of functioning and age.

The results show no significant differences in number of generated words between the Asperger syndrome group and the HFA group in all verbal fluency tasks. The Asperger syndrome group differed significantly from the neurotypical group only in the semantic fluency tasks using professions. A careful look at the professions task reveals that this is the only verbal fluency task used in this study encompassing social elements. This may have negatively influenced the performance of the two disorder groups. The relatively unimpaired verbal fluency in the Asperger syndrome group may indicate that the executive impairment found in children with Asperger syndrome (Nyden, Gillberg, Hjelmquist, & Heman, 1999; Ozonoff, Rogers & Pennington, 1991) diminishes during lifetime. This hypothesis may have significant implications for the clinical practice. A decrease of executive impairment, possibly enhanced by treatment programs, can positively influence opportunities in work and education, which may improve outcome of individuals with Asperger syndrome.

4.2. The relationship between verbal fluency performance and processing speed

The present findings indicate that processing speed is an important underling factor of verbal fluency performance in adults with HFA or Asperger syndrome, since the impairments on two of the three verbal fluency tasks can be attributed to performance speed differences between the three diagnostic groups. Similar results were found for individuals with Huntington's disease, schizophrenia and depression, in which the fluency deficits did not qualify as differential deficits relative to psychomotor speed (Henry & Crawford, 2005a,b; Henry et al., 2005). In the present study, only the impairment on the verbal fluency task using professions could not be attributed to differences in processing speed. As previously mentioned, the social constraints of this task may have influenced performance in the HFA and the Asperger syndrome group negatively.

4.3. Cluster-size and switching

Both switching problems and a lack of use of strategy can be hypothesized for individuals with HFA or Asperger syndrome. Switching problems are expected to lead to long clusters and relatively few switches between clusters (Reverberi et al., 2006). A limited use of strategy is expected to lead to a small mean cluster size and to large numbers of switches (Reverberi et al., 2006). In this study, however, no differences in clustering and switching were found. When the relatively minor generation of words is taken into account, no differences appeared between the three diagnostic groups. Reverberi et al. (2006) state that a small number of words produced combined with normal clustering and switching can point to an isolated initiation and activation deficit and thus a relatively slow word retrieval. This is in line with the relationship between speed of information processing and fluency performance that was found in the HFA group.

5. Conclusions

The present study identified deficits in individuals with HFA in two semantic fluency tasks and in the phonemic fluency task using the letter M. The Asperger syndrome group was only impaired in semantic fluency when professions were used, which may be due to the social constraints of this specific subtask. No impairments were found for the switching or clustering abilities of both disorder groups. The impairments on the semantic fluency tasks using animals and the phonemic fluency task using the letter M can be attributed to the relatively low processing speed of the HFA group. Apparently, adults with HFA or Asperger syndrome show normal use of strategies and have normal switching abilities compared to a neurotypical group. The virtually intact verbal fluency in the adult Asperger syndrome group of this study gives rise to the hypothesis that the deficits in executive functioning found in children with Asperger Syndrome reduce as children grow older and largely disappear during adulthood.

6. Limitations

In this study no statistical significant differences in clustering and switching abilities were found between the individuals in the three groups studied. However, this can be due to the limited power of our analysis, as this part of the study was based on relatively few individuals (Cohen, 1988). To settle this issue, further studies are needed with larger groups of neurotypical individuals and individuals with HFA and Asperger syndrome elaborating the role of these abilities in verbal fluency functioning more thoroughly. There is also a need for future research with larger samples to further investigate the underlying mechanisms of verbal fluency, particularly with regard to the role of processing speed in individuals with HFA and Asperger syndrome. Furthermore, longitudinal research is needed to test the hypothesis arisen in this study that impairment in executive functioning diminishes in adulthood in individuals with Asperger syndrome.

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