Sex Differences in Verbal Fluency Among Young Adults

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ABSTRACT

Verbal fluency tasks have been used as tools to measure various cognitive processes, such as executive functions, memory, and language. Sex differences in verbal fluency performance have been mostly investigated in population studies. Little of this research has focused on young adults. The goal of this study was to assess the impact of sex and task category on word production and verbal strategies (i.e., cluster size and switches) in young adults. The phonemic (letter "k", letter "f") and semantic (animals, fruits, sharp objects) fluency measures were used. Men and women were compared in terms of the number of produced words and the use of verbal strategies (number of switches and mean cluster size controlled for produced words). Results revealed subtle sex differences in verbal fluency in young adults. Men performed slightly better in semantic fluency, producing more words, while there were no sex differences in verbal strategies. There were also no sex differences in word production and verbal strategies in the phonemic fluency tasks. Furthermore, there were differences in the number of produced words, mean cluster sizes, and switches between semantic tasks as well as between phonemic tasks. These results can be interpreted in the context of potential differences in mental lexicon and social roles. Moreover, our results suggest that assessment of verbal strategies and overall word production may be important in the context of sex differences in verbal fluency among young adults as well as in neuropsychological diagnosis.

KEYWORDS

verbal fluency
switching
clustering
sex differences
individual differences

INTRODUCTION

Psychology has long been interested in the differences in mental functions between men and women. It was widely believed that women have better verbal skills than men (Hyde & Linn, 1988). However, a critical review concerning these differences indicates that sex differences in language functions may be marginal (Wallentin, 2009). There have been attempts to assess the nature of sex differences in language functions, especially using verbal fluency tasks (Weiss et al., 2003). However, only some of the studies have showed women having a significant advantage in terms of the number of produced words (Costa et al., 2014; Weiss et al., 2006). Moreover, these differences were rarely assessed in young adults.

Verbal fluency tasks have been frequently used in neuropsychology to assess fluency, that is, "the efficiency with which one creates, plans, and executes a sequence of unautomated activities of a given kind in a limited time, without repeating those that were already completed" (Łojek & Stańczak, 2005, p. 94). Two types of verbal fluency are commonly distinguished: fluency congruent with a formal criterion (phonemic) and congruent with a content criterion (semantic; Troyer, 2000). A distinct type of more ambiguous categories within semantic fluency are, for example, "supermarket items" or "sharp objects", allowing one to produce words referring to more abstract categories (Szepietowska & Gawda, 2011; Wysokiński et al., 2010).

The results of verbal fluency tasks can be used to assess executive functions and cognitive processes in both healthy individuals and

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clinical groups. Lezak (1995) pointed out that these tasks have features of executive processes, because they consist of an initiation of verbal activity, a continuation for a period of time, and its completion after a certain time. Moreover, the organization of words in the mental lexicon can favor a more efficient extraction of words by the attentional-executive system and facilitate the generation of words from distinct subcategories in the semantic fluency tasks. The mental lexicon is involved in the performance of semantic tasks in particular. There may be subtle sex differences conditioned by the experiences gained during the development of social roles. For example, men may use tools more often, producing more words from such a subcategory, while women tend to shop more often, therefore producing more words from the fruit category (Kosmidis et al., 2004). According to the hunter-gatherer hypothesis, the organization of the mental lexicon may depend on the social roles acquired in development (Wallentin, 2009). There may be some sex differences in the mental lexicon that facilitate the performance in distinct subcategories of verbal fluency tasks. Verbal fluency tasks have also been used to assess the functioning of the frontal lobes (Henry & Crawford, 2004). It has been shown that lower scores, especially for phonemic fluency, may be evidence of executive function disorders (Alvarez & Emory, 2006) or of side effects from treatments targeting subcortical brain structures (Højlund et al., 2017).

In attempts to understand the nature of the mental functions which are involved in verbal fluency task completion, apart from counting the number of words produced that fit a given criterion, indicators of verbal strategies have also been used (e.g., the number of switches and the mean cluster size). The number of switches is considered to be mostly a measure of the basic executive process of mental flexibility, that is, mental set shifting (Ross et al., 2005; Troyer et al., 1997). On the other hand, the size of clusters is considered to be an indicator of semantic memory (Ross et al., 2005). Creating clusters is based on extracting words from memory according to the given categories, and then switching to another subset after exhausting examples from one subset of the category (Oppenheimer, 2008; Troyer et al., 1997).

As summarized in Table 1, numerous studies have reported inconsistent results in sex differences in verbal fluency in healthy adults. The number of words produced was analysed most frequently for the phonemic task, whereas for the semantic task, the number of words produced for a large category ("animals") was assessed more often than the number of words produced for a small category ("fruit"). In some studies, women scored better in phonemic fluency (Bolla et al., 1990; Burton et al., 2005; Capitani et al., 1998; Costa et al., 2014; Crossley et al., 1997; Halari et al., 2006; Halpern & Wright, 1996; Herlitz et al., 1999; Scheuringer & Pletzer, 2017; Weiss et al., 2003; Weiss et al., 2006). However, more often, no sex differences were found (Brickman et al., 2005; Cavaco et al., 2013; Dursun et al., 2002; Khalil, 2010; Lewin et al., 2001; Mathuranath et al., 2003; Scheuringer et al., 2017; Tombaugh et al., 1999; Troyer et al., 1997). There were usually no sex differences in "animal" fluency, with the exception of one study, where men performed better at this task (Gawda & Szepietowska, 2013b). Similarly, in most studies, no differences were observed between men and women in terms of "fruit" fluency. However, women outperformed men in this task in four studies, (Acevedo et al., 2000; Capitani et al., 1999; Laws, 2004; Szepietowska & Gawda, 2011) as well as in one study that used a mix of categories ("animal," "fruit," and "color:" Costa et al., 2014). To our knowledge, studies referring to specific subtypes of semantic fluency for example, "sharp objects," have not been conducted in groups of young adults. However, there are some population-based studies with wide age ranges. Wysokiński et al. (2010) showed that healthy participants produce less words in the "sharp object" category than in the animal category, but did not investigate sex differences with respect to these categories.

Researches focusing on between-sex comparisons have, for the most part, not analysed indicators referring to verbal strategies (switching and clustering). The study by Weiss et al. (2006) is an exception where women were reported to make a higher number of switches in the phonemic fluency task. Similar results were obtained by Szepietowska and Gawda (2011). On the other hand, in another study by Gawda and Szepietowska (2013b), men were shown to make a higher number of switches in the semantic fluency test. These studies either did not show differences between men and women in terms of cluster size in both phonemic and semantic fluency or they did not assess these indices at all. A comparison of results obtained by different authors is difficult because of, among other things, the varying age of participants and task types. In summary, the results of prior studies are inconclusive with respect to the differences between the performance of men and women in verbal fluency tasks.

Despite the fact that participant age has been shown as important factor for verbal fluency performance, only few studies have investigated sex differences for different age groups. It was shown that there is a decrease in produced words with age, both in phonemic and semantic fluency tasks (Brickman et al., 2005; Capitani et al., 1999; Loonstra et al., 2001; Tombaugh, 1999). One study confirmed the advantage of women over men aged above 40 in phonemic fluency only, but at the same time, no sex differences were shown between young adults (Capitani et al., 1998).

One conclusion that can be drawn from the presented literature review is that the question of sex differences in verbal fluency has not been clearly answered. Our study aimed to fill this gap by investigating healthy young adults as well as by focusing on the use of verbal fluency strategies. Some studies have only shown differences in some indices of task performance, usually to the advantage of women, and these differences were observed in individuals whose ages ranged from early to very late adulthood. The existing literature regarding sex differences in verbal fluency is thus inconclusive. Sex differences in young adults were examined in only five of the studies reviewed above. Three studies (Halari et al., 2006; Herlitz et al., 1999, Lewin et al., 2001) used only a phonemic fluency task, and the authors presented results regarding a primary indicator, that is, the number of words. Two studies (Lanting et al., 2009; Scheuringer & Pletzer, 2017) analysed verbal strategies, that is, clustering and switching. However, Lanting et al. (2009) used only the "animal" category in semantic fluency in addition to phonemic fluency (participants were asked to produce words starting with the letters "C," "L," and "F"). Scheuringer and Pletzer (2017) used more categories

TABLE 1.
Survey on Studies for Sex Differences in Produced Words in Verbal Fluency Tasks

Author/s	Number of participants All/Men/ Women	Age range	Mean age All/Men/ Women	Semantic fluency		Phonemic fluency	
				Criterion	Differences	Criterion	Differences
Bolla et al. (1990)	199/80/119	39–89	64.30/NI/NI	NI	NI	F, A, S	Women better
Halpern and Wright (1996)	150/72/78	18–54	29.21/NI/NI	NI	NI	R, L, M, P, R, A, S	Women better
Crossley et al. (1997)	635/NI/NI	NI	NI/NI/NI	Animal	No	F, A, S	Women better
Troyer et al. (1997)	95/42/53	18–89	NI/NI/NI	Animal	No	F, A, S	No
Capitani et al. (1998)	503/221/282	18–81	45.60/NI/NI	NI	NI	F, P, L	Women better
Kempler et al. (1998)	317/112/205	54–99	73.00/73.40/72.70	Animal	Men better	NI	NI
Capitani et al. (1999)	266/112/154	18–96	53.90/NI/NI	Animal Fruit	No Women better	NI	NI
Herlitz et al. (1999)	200/100/100	20–40	NI/28.16/28.03	NI	NI	F, A, S	Women better
Tombaugh et al. (1999)	1300/559/741 735/310/425	16–95 16–95	60.70/NI/NI 67.00/NI/NI	NI Animal	NI No	F, A, S NI	No NI
Acevedo et al. (2000)	553/155/398	50–90	NI/NI/NI	Animal Fruit	No Women better	NI	NI
Lewin et al. (2001)	185/91/94	20–40	NI/29.90/28.83	NI	NI	F, A, S, N	No
Dursun et al. (2002)	NI/NI/NI	13 – 67	NI/27/39	NI	NI	F, A, S	No
Mathuranath et al. (2003)	153/91/62	55–84	66.94/NI/NI	Animal	No	P	No
Weiss et al. (2003)	97/46/51	NI	NI/26.17/23.92	Animal, Vegetables, Supermarket	No	B, A, S	Women better
Kosmidis et al. (2004)	300/140/160	18–79	NI/46.40/46.60	Animals, Fruit, Objects	No, Women better, No	X (Chi), Σ (Sigma), A (Alpha)	No
Laws (2004)	600/300/300	NI	NI/30.17/31.50	Animal Fruit	No Women better	NI	NI
Brickman et al. (2005)	471//230/241	21–82	NI/NI/NI	Animal	No	F, A, S	No
Burton et al. (2005)	134/41/93	NI	NI/19.30/20.00	NI	NI	C, S	Women better
Halari et al. (2006)	19/9/10	20–30	NI/25.78/24.90	NI	NI	F, A, S, P, R, W	Women better
Weiss et al. (2006)	80/40/40	NI	NI/25.45/24.98	Animal	No	F, A, S	Women better
Lanting et al. (2009)	60/29/31	18–40	28.80/NI/NI	Animal	No	C, F, L	No
Khalil (2010)	215/125/90	17–59	27.40/NI/NI	Animal	No	W, R G	No
Szepietowska and Gawda (2011)	200/129/71	18–70	37.77/NI/NI	Animal Fruit	No Women better	NI	NI
Munro et al. (2012)	957/477/480	67–88	NI/76.00/76.00	Animal Supermarket	No	S, P	Men better
Gawda and Szepietowska (2013a)	302/164/138	18–70	NI/31.27/32.26	Animal	No	NI	NI
Gawda and Szepietowska (2013b)	200/71/129	18–70	NI/32.10/40.40	Animal Fruit	Men better No	NI	NI

TABLE 1.
Survey on Studies for Sex Differences in Produced Words in Verbal Fluency Tasks (Cont.)

Author/s	Number of participants All/Men/ Women	Age range	Mean age All/Men/ Women	Semantic fluency		Phonemic fluency	
				Criterion	Differences	Criterion	Differences
Cavaco et al. (2013)	950/326/624	18–98	57.80/NI/NI	Animal	No	M, R, P	No
Costa et al. (2014)	335/146/189	20–90	55.90/NI/NI	Mixed: animal, fruit, colour	Women better	F, A, S	Women better
Zarino et al. (2014)	290/142/148	19–98	54.10/NI/NI	Animal Fruit	No No	NI	NI
Scheuringer et al. (2017)	42/23/19	NI	NI/22.70/22.90	Animal, Fruit, Vegatable, Furniture, Clothing, Jobs, Male Names, Female Names	No	P, A, N, S, E, M, F, O, T	No
Scheuringer and Pletzer (2017)	100/51/49	18–36	NI/23.65/22.57	Animal, Fruit, Beverages, Food, Furniture, Clothing, Jobs, Cities, Countries, Toys, Sports, Transportation	Women better	P, N, M, S, H, L, F, T, D, W, K, R	Women better

Note. NI = no information; No = no differences. In semantic fluency, the participants were asked to produce words belonging to given category. In phonemic fluency, the participants were asked to produce words starting with letters according to the criterion.

(12 for each: semantic and phonemic), but analysed only summarized indicators for the number of words, clustering, and switching, and not for each different type of task. Thus, it is unclear what verbal strategies young adults use in different types of semantic and phonemic fluency. Young adults are an understudied population and potential sex differences in this age range remain an open question. It is not entirely clear to what extent executive functions and mental lexicon determine the performance in various tasks in men and women. Distinct subcategories of verbal fluency tasks as well as verbal strategies may play an important role in the assessment of mental processes, being a better indicator than the number of produced words itself. Therefore, considering the discrepancy in the aforementioned results, we investigated the number of words produced and verbal strategies used in five verbal fluency tasks in men and women. The aim of this study was to examine sex differences in verbal fluency tasks in a group of young adults.

METHODS

Participants

One hundred and forty young adults (70 women and 70 men) took part in the study. They were either university students of various disciplines (students of psychology and cognitive science were excluded) or full-time employees. They were recruited through advertisements. All participants were fluent in Polish. A psychological interview which included questions about inclusion and exclusion criteria was conducted with each of the participants. The inclusion criteria were: being aged between 20 and 30, having over 12 years of education, right-handedness, and the ability to understand the test procedures and to give informed consent to taking part in the study. Exclusion criteria included mental or neurological illness, a history of traumatic brain injury, alcohol or drug dependence, as well as untreated serious chronic illness. The age of the participants ranged between 20 and 29 (women: $M = 21.80$, $SD = 2.21$; men: $M = 22.34$; $SD = 2.48$), and their years of education ranged from 12 to 22 (women: $M = 14.53$, $SD = 2.08$; men: $M = 14.70$, $SD = 1.90$). The participants were divided into two groups based on their sex, of equal size, age ($Z = -1.61$; $p = .11$) and years of education ($Z = -0.78$; $p = .44$). Informed consent was obtained from all participants individually. The study was conducted in accordance with the protocol approved by the local Research Ethics Committee and with the 1964 Helsinki declaration and its later amendments.

Fluency Tasks

The verbal fluency tasks included five semantic categories and were all conducted in Polish. The tasks were completed in the following order: (a) "animal" fluency, (b) "fruit" fluency, (c) "sharp objects," (d) words starting with the letter "k," and (e) words starting with letter "f." The "animal" category may be considered a larger semantic category than "fruit" because it contains more specimens in biological taxonomy and is better represented in memory, as indicated in stud-

ies by Azuma et al. (1997) and Crowe (1998). Similarly to semantic fluency, in the phonemic tasks, we distinguished between a large category - words starting with the letter "k," which are common in the Polish language, and a narrow category - words starting with letter "f", which are less common (Jodzio, 2008). Participants heard the prompts and were given 1 min to complete each task. We recorded and later transcribed the participants' spoken answers. We differentiated between the following indices: (a) the number of words fulfilling the criterion (for each of the five tasks testing semantic and phonemic fluency); and (b) verbal strategies, that is, the number of switches and mean cluster size (for semantic and phonemic fluency). To control for differences in the number of produced words, the number of switches and the cluster size were divided by the total number of words produced by the participant. The correction was applied because the number of switches and the mean cluster size strongly depend on the number of produced words in distinct verbal fluency tasks. Thus, the lack of such a correction could impact the results as low word production may result in both a small cluster size and infrequent switching. Switching was defined as shifting between clusters, between free words, or between clusters and free words. We used the raw number of switches because it best described the behaviour of interest. To this end, we used a strategy described by Troyer et al. (1998). Mean cluster size was calculated by dividing the sum of words within clusters by the number of clusters. We also assumed, in line with Troyer et al.'s (1997) strategy, that a semantic cluster in "animal" fluency was constituted by at least two examples belonging to the given semantic subcategory (such as insects, fish, birds etc.). In "fruit" fluency, a cluster was made of subcategories such as a country's produce, exotic fruits, berries, and so forth. In "sharp objects" fluency, examples of more concrete categories were different tools (e.g., kitchen, garden, and building tools), and examples of more abstract categories were "spices" and "body parts." In Polish, the "sharp objects" category covers both the meanings "sharp" and "spicy," unlike in English. On the other hand, a phonemic cluster consisted of at least two words starting with the same phoneme, differing only by a vowel, or being homophones, for example, in Polish: "kot" – "kod" ("cat" and "code," respectively). Only clusters which fulfilled the criterion were scored, that is, semantic clusters for semantic fluency and phonemic clusters for phonemic fluency. Repetitions and words that did not fulfil the criterion were not included in the subsequent analyses.

Data Analyses

Data were analysed using the SPSS Statistics 24 software. Continuous variables are presented as means and *SD*s. The normal distribution of variables was tested using the Shapiro-Wilk test. The nonparametric Mann-Whitney's *U* test was used to test the differences between groups in demographic variables (age and education). To analyse the three dependent measures (number of produced words, cluster size, and number of switches), mixed-effects analyses of variance (ANOVAs) were used with Bonferroni's post hoc tests. Detailed statistical analyses were made separately for the semantic and phonemic tasks. Bonferroni corrections were used where applicable.

RESULTS

Effects of Sex and Task on Number of Produced Words

SEMANTIC FLUENCY

To test the potential sex differences in the number of words produced in the semantic fluency tasks, a 2 × 3 ANOVA with the between-subjects factor of sex and the within-subject factor of task ("animal" vs. "fruit" vs. "sharp objects" fluency) was carried out for the dependent variable of number of words. Results are presented in Figure 1, Panel A.

The main effect of sex was small and significant, $F(1, 138) = 7.09$; $p = .009$; $\eta^2 = .05$, indicating that men ($M = 15.62$, $SD = 4.58$) produced more words than women ($M = 14.27$, $SD = 3.77$) in semantic tasks. The main effect of task was large and significant, $F(2, 276) = 421.12$; $p < .001$; $\eta^2 = .75$, indicating that the differences in word generation between the three semantic tasks were present in all participants. A post hoc analysis showed that participants produced more words in the "animal" ($M = 21.34$, $SD = 5.48$) than in the "fruit" fluency task ($M = 15.19$, $SD = 3.49$; $p < .001$), in the "fruit" ($M = 15.19$, $SD = 3.49$) than in the "sharp objects" fluency task ($M = 8.30$, $SD = 3.56$; $p < .001$), and in the "animal" ($M = 21.34$, $SD = 5.48$) than in the "sharp objects" fluency task ($M = 8.30$, $SD = 3.56$; $p < .001$). Furthermore, the interaction between sex and task was small and significant, $F(2, 276) = 5.15$; $p = .008$; $\eta^2 = .04$. Pairwise comparisons showed that men were better than women in "animal" ($p = .003$) and "sharp objects" fluency tasks ($p = .022$). In both groups (i.e., in women and in men), pairwise comparisons revealed that participants produced more words in the "animal" than in "fruit" fluency task, in the "fruit" than in "sharp objects " fluency task, and in the "animal" than in "sharp objects" fluency task ($p < .001$ for each comparison).

PHONEMIC FLUENCY

To test the sex differences in the number of words produced in phonemic fluency, a 2 × 2 ANOVA with the between-subjects factor of sex and the within-subject factor of task (letter "k" vs. letter "f") was carried out for the dependent variable of number of words. Results are presented in Figure 1, Panel B.

The main effect of sex was nonsignificant, $F(1, 138) = .73$; $p = .396$; $\eta^2 = .00$, indicating that women ($M = 12.58$, $SD = 3.80$) and men ($M = 12.06$, $SD = 4.34$) did not differ in the number of words produced in the phonemic tasks. The main effect of task was large and significant, $F(1, 138) = 317.41$; $p < .001$; $\eta^2 = .70$, indicating that participants produced more words in the letter "k" ($M = 15.17$, $SD = 4.34$) than in the letter "f" fluency task ($M = 9.46$, $SD = 3.80$). The interaction between sex and task was nonsignificant, $F(1, 138) = .31$; $p = .578$; $\eta^2 = .00$.

Effects of Sex and Task on Cluster Size Controlled for Produced Work

SEMANTIC FLUENCY

To test the potential sex differences in cluster size controlled for produced words in semantic fluency, a 2 × 3 ANOVA with the between-subjects factor of sex and the within-subject factor of task ("animal" fluency vs. "fruit" fluency vs. "sharp objects") was carried out for the dependent variable of cluster size. Results are presented in Figure 1, Panel C.

The main effect of sex was nonsignificant, $F(1, 138) = .16$; $p = .690$; $\eta^2 = .00$, indicating that women ($M = 0.19$, $SD = 0.08$) and men ($M = 0.18$, $SD = 0.08$) did not differ in cluster size in the semantic tasks. The main effect of task was large and significant, $F(2, 276) = 59.02$; $p < .001$; $\eta^2 = .30$, indicating that the differences in average cluster sizes between the three semantic tasks were present in all participants. A post hoc analysis presented that participants had higher cluster size in the "sharp objects" ($M = 0.24$, $SD = 0.15$) than in the "animal" fluency task ($M = 0.12$, $SD = 0.03$; $p < .001$), in the "sharp objects" ($M = 0.24$, $SD = 0.15$) than in "fruit" fluency task ($M = 0.18$, $SD = 0.06$; $p < .001$), and in the "fruit" ($M = 0.18$, $SD = 0.06$; $p < .001$) than in the "animal" fluency task ($M = 0.12$, $SD = 0.03$; $p < .001$). The interaction between sex and task was nonsignificant, $F(2, 276) = 3.26$; $p = .065$; $\eta^2 = .02$.

PHONEMIC FLUENCY

To test the sex differences in cluster size controlled for produced words in phonemic fluency, a 2 × 2 ANOVA with the between-subjects factor of sex and the within-subject factor of task (letter "k" vs. letter "f") was carried out for the dependent variable of cluster size. Results are presented in Figure 1, Panel D.

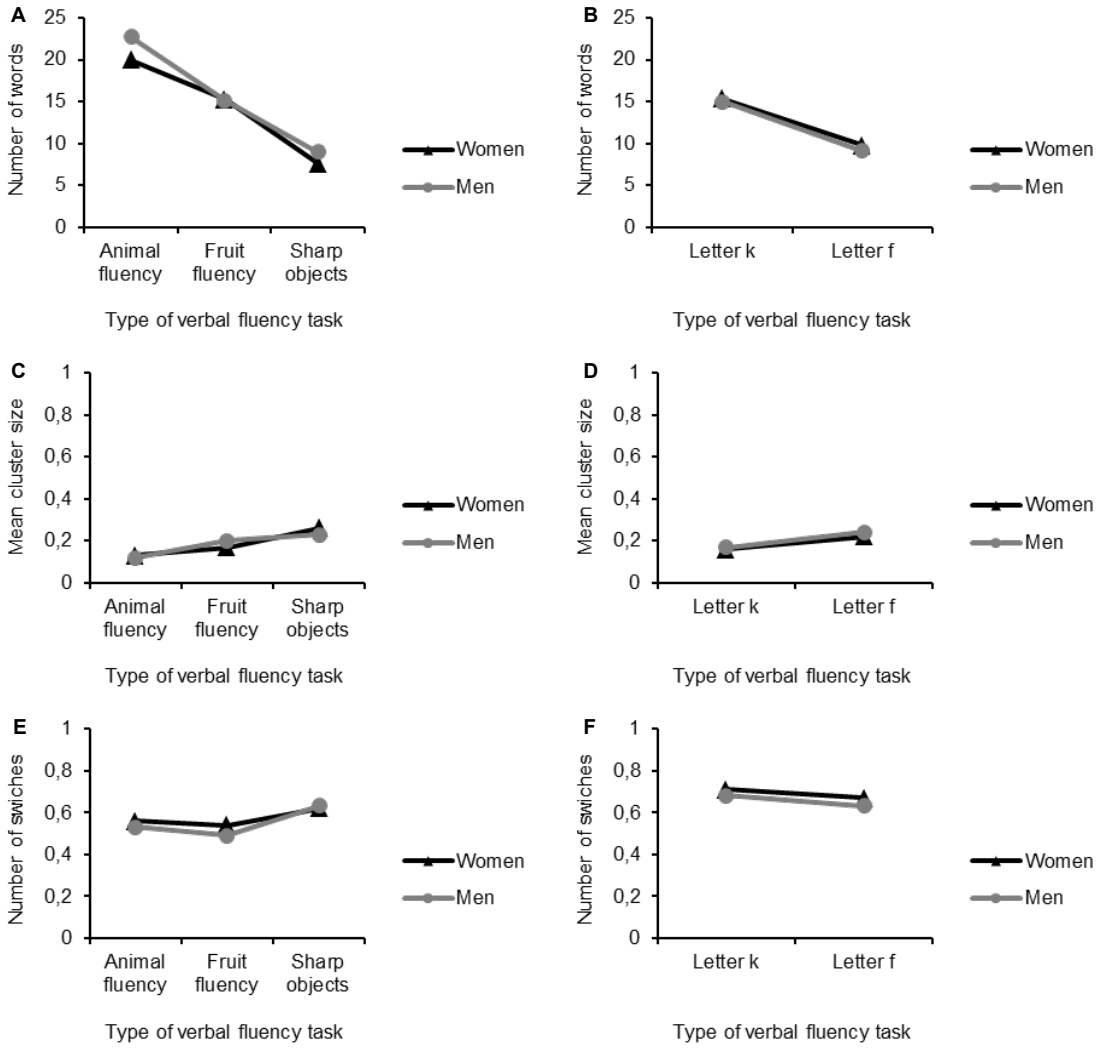

FIGURE 1.

Mean number of words (A and B), and cluster size (C and D) and number of switches (E and F) produced by women and men in semantic (animal, fruit, sharp objects) and phonemic (letter k, letter f) fluency controlled for the number of produced words.

The main effect of sex was nonsignificant, $F(1, 138) = 1.05$; $p = .308$; $\eta^2 = .01$, indicating that women ($M = 0.19$, $SD = 0.11$) and men ($M = 0.21$, $SD = 0.13$) did not differ significantly in cluster size in the phonemic tasks. The main effect of task was large and significant, $F(1, 138) = 21.85$; $p < .001$; $\eta^2 = .14$, indicating that cluster size was higher in the letter "f" ($M = 0.23$, $SD = 0.16$) than in the letter "k" fluency task ($M = 0.16$, $SD = 0.08$). The interaction between sex and task was nonsignificant, $F(1, 138) = .07$; $p = .788$; $\eta^2 = .00$.

Effects of Sex and Task on Switches Controlled for Produced Work

SEMANTIC FLUENCY

To test the potential sex differences in the number of switches controlled for produced words in semantic fluency, a 2 × 3 ANOVA with the between-subjects factor of sex and the within-subject factor of task ("animal" fluency vs. "fruit" fluency vs. "sharp objects") was carried out for the dependent variable of number of switches. Results are presented in Figure 1, Panel E.

The main effect of sex was nonsignificant, $F(1, 138) = 2.66$; $p = .105$; $\eta^2 = .02$, indicating that women ($M = 0.57$, $SD = 0.12$) and men ($M = 0.55$, $SD = 0.14$) did not differ significantly in the number of switches in the semantic tasks. The main effect of task was large and significant, $F(2, 276) = 26.84$; $p < .001$; $\eta^2 = .16$, indicating that the differences in the number of switches between three semantic tasks were present in all participants. A post hoc analysis indicated that participants had a higher number of switches in the "sharp objects" ($M = 0.63$, $SD = 0.16$) than in the "animal" fluency task ($M = 0.54$, $SD = 0.11$; $p < .001$) and in the "sharp objects" ($M = 0.63$, $SD = 0.16$) than in the "fruit" fluency task ($M = 0.52$, $SD = 0.13$; $p < .001$). The interaction between sex and task was nonsignificant, $F(1, 138) = 1.47$; $p = .232$; $\eta^2 = .01$.

PHONEMIC FLUENCY

To test the potential sex differences in number of switches controlled for produced words in phonemic fluency, a 2 × 2 ANOVA with the between-subjects factor of sex and the within-subject factor of task (letter "k" vs. letter "f") was computed for the dependent variable of number of switches. Results are presented in Figure 1, Panel F.

The main effect of sex was nonsignificant, $F(1, 138) = 1.83$; $p = .178$; $\eta^2 = .01$, indicating that women ($M = 0.69$, $SD = 0.16$) and men ($M = 0.66$, $SD = 0.16$) did not differ significantly in the number of switches in the phonemic tasks. The main effect of task was medium and significant, $F(1, 138) = 6.65$; $p = .011$; $\eta^2 = .05$, showing that the number of switches was higher in the letter "k" ($M = 0.70$, $SD = 0.15$) than in letter "f" fluency task ($M = 0.65$, $SD = 0.17$). The interaction between sex and task was nonsignificant, $F(1, 138) = .05$; $p = .832$; $\eta^2 = .00$.

DISCUSSION

The aim of the current study was to assess sex differences in the performance of verbal fluency tasks in a group of young adults, taking into account the employed verbal strategies. This study is the first to investigate sex differences in young adults using Troyer et al.'s (1998) scoring procedure for examining differences in switching and clustering in different subcategories (in contrast to concatenated categories i.e., semantic or phonemic) including three semantic tasks: fluency in the "animal," "fruit," and "sharp objects" semantic categories as well as two phonemic tasks: fluency in the letter "k" and "f" semantic categories. These additional scorings of different fluency tasks contributed to a better understanding of the cognitive processes that underlie verbal fluency differences between men and women. Specifically, the current study extends the results of previous studies (e.g., findings on sex differences in strategy use in younger participants in studies by Weiss et al., 2006, and Lanting et al., 2009) by analysing clustering and switching in each verbal fluency task separately, as well as by including the less examined "sharp objects" category. Moreover, cluster size and switching were controlled for the number of produced words.

Our results revealed that men had an overall slight advantage in terms of the number of produced words that fit the criterion in "animal" and "sharp objects," but not "fruit" fluency. This is in line with the results obtained by Gawda and Szepietowska (2013b) for "animal" fluency. However, most of the previous studies did not reveal sex differences in these three tasks. As shown in Table 1, only some studies compared men and women in terms of "fruit" fluency. Acevedo et al. (2000), Capitani et al. (1999), Kosmidis et al. (2004), and Laws (2004) have shown an advantage for women in this task.

Our study did not show differences in phonemic fluency. Similar results were obtained by Brickman et al. (2005) and Dursun et al. (2002). Other authors found the opposite, showing advantage for women in phonemic fluency (Bolla et al., 1990; Costa et al., 2014; Halpern & Wright, 1996; Weiss et al., 2006). Only one study (Wysokiński et al., 2010) has been published so far concerning "sharp objects" fluency performance in healthy participants. In that study, (young) men and women were not directly compared. The difference in the number of produced words between semantic fluency tasks was significant, but explained only 4% of the variance. The difference in the number of produced words between the two phonemic fluency tasks did not significantly depend on sex. Scheuringer and Pletzer (2017) and Scheuringer et al. (2017) also found nonsignificant interactions between sex and task factors. However, they operationalized "task" as between-fluency factor (i.e., semantic vs. phonemic fluency), whereas our factor was within the levels of each of the fluencies.

A more in-depth analysis of the results of other studies leads to a partial explanation of the observed discrepancies. Some researchers assessed only individuals aged above 40 (Acevedo et al., 2000; Bolla et al., 1990), while others took into account participants from early to very late adulthood (Brickman et al., 2005; Capitani et al., 1999; Costa et al., 2014; Gawda & Szepietowska, 2013a). The reviewed literature has dealt with people at different stages of life, which limits the usefulness of comparing such results. An example of this could be the work of Capitani et al. (1998), who investigated healthy adults aged between 18 and 81, and showed higher scores for women in phonemic fluency. However, no such differences were visible when analysing a subgroup

of individuals aged between 18 and 29. Therefore, differences between men and women could be considered a characteristic of the overall population, but not the subgroup of young adults. Our results seem understandable in the context of developmental psychology and age differences, suggesting that an age-dependent decline in verbal fluency may be different for men and women (Capitani et al., 1998).

Some authors suggest that the effect of aging on switching in verbal fluency tasks is consistent with the hypothesis of executive function decline in normal aging (Troyer et al., 1997; Lanting et al., 2009; Jurado & Rosselli, 2007). Decreased executive functioning in older adults is linked to altered brain activity, especially the prefrontal cortex (Turner & Spreng, 2012), as well as shrinkage of neurons, reduction of synaptic spines, decreased number of synapses, accounting for reductions in grey matter (Fjell & Walhovd, 2010), and increased prevalence of medical and neurological illnesses. Moreover, it is postulated that larger clusters reflect increases in vocabulary size and semantic knowledge over the lifespan (Lanting et al., 2009; Troyer et al., 1997). Interestingly, Stolwyk et al. (2015) showed that age did not predict phonemic fluency in either young or old adults. However, age was negatively related with produced words in semantic fluency tasks in older adults, but not in young adulthood. Overall, these studies suggest that age-related differences in verbal fluency occur later in life. Hence, there may be little to no sex differences in the young healthy adult population (in general word production in verbal fluency tasks rather than in the use of verbal strategies, which were not analysed by Stolwyk et al., 2015).

There were no sex differences in cluster size in our study. Weiss et al. (2006) demonstrated no such differences in "animal" and phonemic fluency tasks. On the other hand, Lanting et al. (2009) showed an advantage for men in cluster size in both semantic and phonemic fluency, but Kosmidis et al. (2004) indicated an advantage for women in cluster size, but only in "fruit" fluency. There were no differences in the number of switches in three semantic and two phonemic fluency tasks in our study. Similar results were obtained by Szepietowska and Gawda (2011). Weiss et al. (2006) indicated an advantage of women in switching in phonemic fluency, yet Lanting et al. (2009) found that women switched more often in semantic fluency. In turn, Gawda and Szepietowska (2013a, 2013b) showed that men performed a higher number of switches in semantic fluency tasks. The differences in cluster size between the three semantic fluency tasks and the two phonemic fluency tasks, as well as in switching between two phonemic fluency tasks, did not significantly depend on sex. The interaction between task and sex for switching in semantic fluency was not significant, but contributed to only 3% of the explained variance. Similar results were obtained by Scheuringer and Pletzer (2017) and Scheuringer et al. (2017), where little or no variance was explained by the interaction.

Furthermore, the main effects of task on the number of produced words in the three semantic fluency tasks and the two phonemic fluency tasks were both significant, and they explained 70–75% of the variance. This suggests a difference in cognitive processing when producing words from categories characterized by different word frequencies in semantic or phonemic categories. These was a significant main effect of task on cluster size in the three semantic fluency tasks and the two phonemic fluency tasks. However, task type explained 30% of the variance in semantic fluency and 14% in phonemic fluency. Differences in clustering may be potentially more dependent on semantic memory in semantic than phonemic fluency. There was also a significant main effect of task on switching in the semantic and the phonemic fluency tasks (16% and 5% explained variance, respectively). Mental flexibility, which is associated with switching, is crucial for both semantic and phonemic fluency tasks. Szepietowska and Gawda (2011) showed differences in fluency task performances, but aside from "animals" and "fruit," they concerned different categories for example, affective fluency (pleasant, unpleasant) and associative fluency. It is worth noting that both clustering and switching were highly correlated with the number of produced words. The use of these strategies has been linked to the overall word production in other studies (Kosmidis et al., 2004; Weiss et al., 2006). Despite switching being seemingly more important for overall score, both strategies (number of switches as well as mean cluster size) are important for correct and effective task completion independent of its type–conclusions which are in line with the work of Unsworth el al. (2010), Weiss et al. (2006), and Zawadzka and Domańska (2010).

The current study supports the two-component model of verbal fluency production (Troyer et al., 1997). According to this model, switching is a prefrontal cortex executive function and clustering is a temporal cortex memory function. Our study supports the notion that men and women may rely on the same strategies on verbal fluency tasks. Although Lanting et al. (2009) suggested that switching may be a strategy compensating the production of smaller clusters, the underlying mechanism for sex differences in verbal strategies remains unclear. It may result from the fact that word production during verbal fluency tasks is a complex process engaging several cognitive functions. Executive functions are responsible for control over the course of the task requiring inhibition of reactions that are not in accordance with the goal (Keil & Kaszniak, 2002). In addition, verbal fluency tasks have been used to measure various cognitive processes, for example, top-down attention, working memory, semantic memory, and speed of information processing (Azuma, 2004; Oppenheimer, 2008; Rende el al., 2002). Word memory recall, as an important element of language functions, depends on the condition and organisation of the semantic system (store) and the efficacy of mechanisms of access to stored information (Goñi et al., 2011). Potential differences between men and women in each of these functions may impact the overall sex differences in verbal fluency. Importantly, Lanting et al. (2009) indicated that overall effect sizes of the differences in verbal fluency between men and women are small, which may explain the null results regarding the use of strategies and overall word production in previous studies.

We have shown that there are at most slight sex differences in overall verbal fluency. We are aware of the fact that our results should be interpreted with caution, as performance in verbal fluency tasks engages many different mental processes which are associated with various brain areas (Yuan & Raz, 2014). Our results can be interpreted in the context of potential differences in mental lexicon and social roles. The hunter-gatherer hypothesis could explain sex differences in mental

lexicon, but Laws (2004) stated that these differences are rather secondary consequences of diverse experiences in evolutionary history. It was suggested that differences in familiarity with distinct semantic categories could potentially explain sex differences in verbal fluency. However, it is not clear how these differences arise and whether they are determined by prior experience or other factors.

We acknowledge that the lack of a general intelligence test is a major limitation to this study. Therefore, we cannot rule out that the obtained slight differences may have resulted from sampling bias. General intelligence has been shown to strongly influence scores on verbal fluency tasks in the healthy population (Ardila et al., 2000) and in clinical samples (Roca et al., 2012). Hence, it is not clear whether the results obtained in our study demonstrate the sex differences or the level of intelligence of the participants. However, as education has been proposed to be a predictor of verbal intelligence (Ritchie & Tucker-Drob, 2018), verbal fluency (Ardila et al., 2006) as well as verbal strategies (Da Silva et al., 2004; Troyer, 2000), we controlled for the effect of education by matching the two groups in terms of years of education. Moreover, there are other nonclinical factors apart from sex which are the basis of individual differences and which may influence scores on verbal fluency tasks. For example, it has been previously shown that age, years of education, hormone levels, sex stereotypes, handedness, sexual orientation, gender identity, and bilingualism (Berenbaum et al., 1995; Hirnstein et al., 2012; Kimura, 1996; Rahman et al., 2003; Rosselli & Ardila, 2003; Soleman et al., 2013). These factors were not measured in the current study and may have influenced the results.

In conclusion, we have examined the potential sex differences in verbal fluency tasks. We have shown that men were better (produced more words) than women in semantic fluency tasks. There were no other differences between men and women. This suggest that there are slight sex differences in verbal fluency among young adults, but only in semantic fluency.

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RECEIVED 19.07.2019 | ACCEPTED 24.02.2020