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Developmental trends in semantic fluency in preschool children

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Abstract: Semantic fluency is a measure of verbal functioning and cognitive flexibility. Its development is particularly rapid in preschool years. The goal of this study was to examine semantic fluency in preschool children in relation to child's age and gender. The sample for this study comprised 133 children aged 3–6 years (mean age = 56.7 months; $SD = 11.1$ months) from Canton Sarajevo, Bosnia and Herzegovina. In relation to child's gender, there were 62 girls (46.6%) and 71 boys (53.8%). We used three different semantic fluency categories: animals, food and music instruments. The results of this study confirmed the effect of age on semantic fluency improvement. However, there were slightly different developmental trends for boys and girls in semantic fluency tasks. Girls achieved higher mean scores in all three semantic fluency tasks, but statistically significant differences were only for the category of music instruments. Given the rapid growth in semantic fluency in preschool children, it is very important to actively promote its development in early years.

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PUBLIC INTEREST STATEMENT

Preschool period is of crucial importance for the development of many important skills, including language skills. With increasing age, children attain more words and are better at retrieving words from their memory. Learning of new words and their successful retrieval is the same for boys and girls. There are no differences in the number of retrieved words between boys and girls for certain category of words such as animals and food items. However, girls could retrieve more words from the category of music instruments than the boys. Probable explanation is that girls have much more interest for music at this age than boys. If we could identify children who have problems at retrieving words from their memory, additional educational programs could help them be more successful at school.



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1. Introduction

The preschool period presents a foundation for child's later personal, social and cognitive functioning. In this period, the basic functions of language and cognition are formed (Howard & Melhuish, 2017). Some functions, such as language, that are established at preschool age are very predictive of later academic outcomes. Many studies point to the relationship between language skills and academic achievement (Rohde & Thompson, 2007; Walker, Greenwood, Hart, & Carta, 1994). In a longitudinal study by Walker et al. (1994), the authors found that preschool language skills were predictive of academic outcomes in third grade. Given its predictive validity, examining certain aspects of language such as verbal functioning can provide researchers with a clearer insight into the cognitive and emotional functioning of an individual.

One of the ways to examine verbal functioning, cognitive flexibility and search strategies is through the measure of verbal fluency (Koren, Kofman, & Berger, 2005; Shao, Janse, Visser, & Meyer, 2014). Verbal fluency can be defined as an ability to retrieve words from the memory in an organized way (John & Rajashekhar, 2014). It is usually assessed with two types of tasks: semantic fluency task and phonological fluency task. Semantic fluency tasks involve production of words that belong to a certain category (e.g. animals), while the phonological fluency involves production of words starting with a particular letter (e.g. words starting with letter "L").

Tests of verbal fluency are often used in neuropsychology (Harrison, Buxton, Husain, & Wise, 2000) as they can point to certain neurologic deficits. For example, patients with Alzheimer, Parkinson and Huntington disease all have impairments in semantic fluency in comparison with healthy control group (Randolph, Braun, Goldberg, & Chase, 1993). Verbal fluency tests are also used to assess deficits in executive functions (Henry & Crawford, 2004).

As the verbal fluency tasks are a good indicator of child's developmental level, these tests have frequently been used in children with developmental disabilities. These tests can be useful for both, as an indicator of quantitative verbal ability (how many words child retrieved) and qualitative verbal performance (what words did the child retrieve). For example, in a study by Wang and Bellugi (1993), the authors found that children with Williams syndrome not only produced more words in semantic fluency task (category of animals) than children with Down syndrome, but also had more unusual selection of animals. This can be very informative for determining their overall developmental level as the semantic development entails not only the increase in the number of acquired concepts but also changes in how knowledge is organized (Fisher, Godwin, Matlen, & Unger, 2015). The number of words retrieved and their selection can be used in correlation and as a proxy for creativity (Silvia, Beaty, & Nusbaum, 2013). Many studies in the domain of semantic fluency have also been conducted in children with autism spectrum disorder (Kleinhans, Müller, Cohen, & Courchesne, 2008; Rapin & Dunn, 2003).

Researchers were particularly interested in developmental changes in semantic fluency happening in the school age. In all these studies there was a clear developmental trend of the positive relationship between age of the child and better performance on verbal fluency task (Riva, Nichelli, & Devoti, 2000). However, it is evident that at some point, linear relationship between age and verbal fluency disappears. For example, in a study by Sauz on, Lestage, Raboutet, N'Kaoua, and Claverie (2004), the authors found that age differences in semantic fluency were gradually reducing with increasing age. Earlier studies in this area have found that at around 10 years of age children reach adults' level of performance (Regard, Strauss, & Knapp, 1982). Until 10 years of age, there seems to be a linear trend of growth in semantic fluency in children. Studies to date have shown that there are differences in semantic knowledge task performance between preschool children and early school

year children (Fisher et al., 2015). It is expected for older children to have better semantic fluency, but exactly what abilities contribute to it is still unknown.

However, we know little about the developmental trends in semantic fluency at preschool age. It would be very useful to know the developmental trajectory of semantic fluency in preschool years as it might help us in designing age appropriate programmes for verbal fluency promotion.

The gender effect in verbal fluency tasks has been explored in many studies (Berninger & Fuller, 1993; Cavaco et al., 2013; Tombaugh, Kozak, & Rees, 1999) and most of the results indicate a lack of gender effect or a small gender effect. This is in line with a large meta-analysis conducted by Hyde and Linn (1988), who pointed that the gender differences were not so large after all and that, in fact, gender differences in verbal ability do not exist. However, most of these studies were performed with adult population and we do not have such data for preschool children. Thus, one of the goals of this study was to explore gender differences in semantic fluency in preschoolers aged 3–6 years old.

Lastly we wanted to examine whether there is an interaction effect of age and gender on semantic fluency tasks. More concretely, we examined whether boys and girls are acquiring semantic fluency skills at approximately the same age.

Thus, the goal of the present study was to examine the developmental trends in semantic fluency in preschool children. In addition to this, we examined the effects of gender on development of semantic fluency in preschool children. In line with the above-mentioned goal, we set three hypotheses:

- (1) There is a linear, positive effect of age on semantic fluency tasks.
- (2) There are no statistically significant differences between boys and girls on semantic fluency tasks.
- (3) There are no interaction effects of age and gender on semantic fluency tasks.

2. Method

2.1. Participants

The sample for this study comprised of 133 preschool children aged 3–6 years (mean age = 56.7 months, $SD = 11.1$ months). There were 62 girls (46.6%) and 71 boys (53.4%) in the sample. There were no statistically significant differences in the mean age between boys and girls ($t = 0.54$; $p = 0.41$). Children were attending public preschool institutions in Canton Sarajevo, Bosnia and Herzegovina. According to the preschool teachers' reports, children were all free of any known neurological and/or psychiatric condition or developmental disability.

2.2. Procedure

Out of 30 public kindergartens in Canton Sarajevo, we randomly (out of the hat) selected eight small-sized public kindergartens (up to 50 children) and provided preschool teachers with the consent forms for parents. We only selected public kindergartens as the Sarajevo Canton Ministry of Education granted us permission for research in public kindergartens. The goals of the study were explained to the preschool teachers. Consent forms contained all the information regarding the study. It was pointed out that participating in the study is on voluntary basis and that the obtained data will be analysed anonymously. This study was part of a larger study examining executive function of preschool children in Canton Sarajevo. We distributed 200 consent forms to the preschool teachers who then distributed the forms to the parents, and 158 forms were signed and returned, 79% response rate. We were not asked to provide additional consent forms to the kindergartens. After the consent forms were returned, we tested the children on a number of tests including finger tapping speed, theory-of-mind Sally–Anne test, executive functions card sorting and semantic fluency tasks. We already reported about the performance of a smaller sample of children (111 children) on a test of

finger tapping speed (Memisevic, Mahmutovic, Pasalic, & Biscevic, 2017). Children were tested by trained data collectors with advanced degrees in psychology, speech and language therapy and special education. All children were tested individually, in the morning hours, in the convenient space at the kindergartens. The complete testing session lasted approximately 15–20 min for each child, with semantic fluency tasks lasting around 6 min. Some children were sick at the time of testing ($n = 15$) or did not want to do the tests ($n = 10$). For all other children, we had complete data for semantic fluency tasks. This left us with the final sample of 133 children. The approval for this study was obtained from the Canton Sarajevo Ministry of Education and the Ethical Committee Board at the Faculty of Educational Sciences at the University of Sarajevo. Only children with the written parental consent were tested.

2.3. Test

Semantic fluency tasks. In this study, we used three semantic fluency tasks, animals, food and music instruments. Children were asked to name as many items from a particular semantic category in 60s. Number of non-repeated retrieved words was used as a dependent variable. All children understood the task and were able to perform it. The test was given in a fixed order to all children: animals, food, music instruments.

2.4. Statistical analysis

For the first hypothesis, the effect of age on semantic fluency task, we calculated Pearson correlation coefficient for the whole sample and for the boys and girls separately. For the second hypothesis, differences on semantic fluency tasks in relation to gender, we presented descriptive data along with an independent t-tests and Cohen's d effect size measure. Lastly, we examined the interaction effects of age and gender on semantic fluency tasks. Data were analysed with the computer program SPSS for Windows (v.13) and in R Core Team (2017). For all tests, an alpha level of statistical significance was set at $p < 0.05$.

3. Results

The first aim of this study was to examine the correlations between age and semantic fluency tasks. In Figure 1 is the scatter plot of correlation between age and semantic category animals.

The correlation (Pearson r) between age and semantic fluency (animals) is $r = 0.49$. As can be seen from the Figure, the developmental trend was very similar between the boys and girls ($r_{\text{girls}} = 0.51$; $r_{\text{boys}} = 0.47$). All these correlations are statistically significant ($p < 0.01$).

In Figure 2 is presented the relationship between age and semantic category food.

Again the correlation between age and semantic fluency, category food, was statistically significant ($r = .42, p < 0.01$). However this correlation in relation to gender was stronger for boys ($r_{\text{boys}} = 0.50, p < 0.01$), than for girls ($r_{\text{girls}} = 0.30, p < 0.05$). It is evident that at younger age, girls have higher scores in this test which tend to equalize at age 6 years.

Figure 1. Correlation between age and semantic fluency category animals.

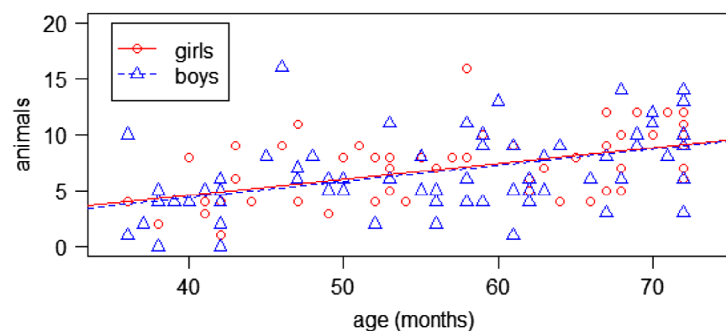


Figure 2. Correlation between age and semantic fluency category food.

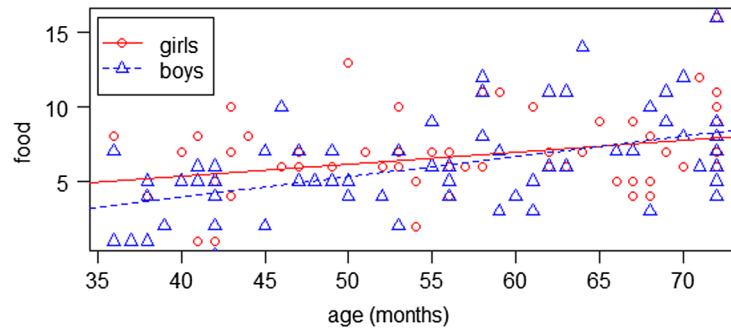
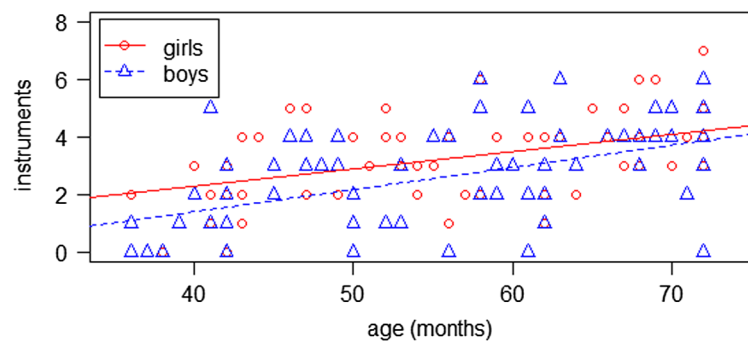


Figure 3. Correlation between age and semantic fluency category instruments.



Lastly, in Figure 3, we present the correlations between child’s age and semantic fluency, category music instruments.

Again, the total correlation was statistically significant ($r = 0.49$; $p < 0.01$). This correlation was similar across gender categories ($r_{\text{boys}} = 0.51$, $r_{\text{girls}} = 0.46$, both p 's < 0.01). Girls tended to have higher scores across the age groups.

Next, we wanted to examine whether there are differences in the mean number of retrieved words from three semantic categories between boys and girls. In Table 1, we presented the mean scores of semantic fluency tasks in relation to gender. This information might be useful to researchers conducting subsequent research in this field.

As can be seen from Table 1, girls achieved better mean scores on all semantic fluency tasks. However, statistically significant differences were found only for the category of music instruments, and not for the categories of animals and food. This table also reveals that the performance of children was lowest for the category of music instruments followed by categories of food and animals, respectively. In addition to this, for the music instruments category, we calculated a Cohen’s d

Table 1. Semantic fluency differences in relation to the child’s gender

Semantic category	Girls		Boys		$t(df = 131)$
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Animals	7.1	3.0	6.7	3.5	0.8
Food	6.7	2.8	6.1	3.1	1.2
Music instruments	3.3	1.4	2.6	1.7	2.6*

Notes: This value is significant even after applying Bonferroni correction for the number of tests performed (0.05/3).

The assumption of equality of variances has not been violated according to the Levene’s tests (all $p > 0.10$).

* $p = 0.011$

Table 2. The interaction effect of age and gender on semantic fluency tasks

Category	Source	df	Sum of squares	F Ratio	Prob. > F
Animals	Gender*age	1	0.003	0.001	0.98
Food	Gender*age	1	13.93	1.90	0.17
Music_in	Gender*age	1	0.97	0.48	0.48

coefficient as a measure of effect size and effect was medium (Cohen's $d = 0.45$). So the girls had a result almost half of the standard deviation higher than the boys on this task.

Lastly, we examined whether there was an interaction effect of age and gender on semantic fluency tasks. The results are shown in Table 2.

As can be seen from the table there were no interaction effects of age and gender on semantic fluency tasks, meaning that developmental trends in semantic fluency were very similar for boys and girls.

4. Discussion

The goal of the present study was to examine the effects of age and gender on three semantic fluency tasks in preschool children. The results of this study support earlier work with a novel sample about the positive correlation between the age of the child and performance on semantic fluency tasks. This trend was obvious across the semantic categories, that is for the category of animals, food and music instruments. In addition to this, the trend was similar in boys and girls, as there were no statistically significant interactions of gender and age on semantic fluency task. As for the number of retrieved words in these tasks, girls achieved somewhat better results. They achieved higher mean scores on all three semantic fluency categories, but statistically significant differences existed only for the category of music instruments. There are several potential cultural and developmental explanations for this particular result. Some of the possible explanations for the better performance of girls on this particular semantic fluency task might be related to gender differences in the functional organization of the brain for language as well as the differences in the speed of information processing. A study by Shaywitz, Shaywitz, Pugh, and Constable (1995) has shown that the brain activity in language tasks is more diffuse in females, involving both cerebral hemispheres, while in males it is lateralized in the left hemisphere frontal regions. Thus, it might have been easier for girls to retrieve words from the memory. Similar explanation was given in a study by Weiss et al. (2006) in which the authors indicated that males and females are using different processing strategies in verbal fluency tasks. There are enough evidence that different brain structures are active during a performance on working memory tasks between males and females. And as the task is becoming harder, it is activating different brain areas (Speck et al., 2000), so this might help explain the girls' advantage. Another potential explanation is that there were some inherent differences in the sample of girls and boys in relation to socio-economic status and/or intellectual functioning. However, as the sample is very likely to be random in relation to gender, this explanation is highly unlikely. An equally possible, cultural explanation is that girls have more preferences towards music at this age and thus achieved better results due to greater exposure to musical instruments. A study by Forgeard, Winner, Norton, and Schlaug (2008) indicates that playing musical instruments at an early age is associated with enhanced verbal ability. However, we did not collect data regarding whether children played a musical instrument. Lastly, as the tasks were presented in the fixed order, we cannot rule out fatigue and attention effects being more pronounced in boys than in girls. Of course, there is always a possibility that the gender differences found were due to chance and that we committed type-1 error (finding differences where there are none). This is also unlikely explanation as there were statistically significant gender differences even after applying more stringent statistical criteria such as Bonferroni correction.

There are inconclusive results on whether differences in semantic fluency exist between males and females. Let us mention some of the studies dealing with the issue of gender effects. We found one study that employed similar research methodology to our study in which the authors measured performance of healthy adults on semantic fluency tasks for four categories: animals, fruits, tools and vehicles (Capitani, Laiacona, & Barbarotto, 1999) and found mixed results. Females were better with fruits and males with tools and for the categories of animals and vehicles there were no statistically significant differences. In another study, John and Rajashekhar (2014) did not find gender effects in their study of children aged 5–15 years. Contrary to this finding, Berninger and Fuller (1993) found gender differences in verbal fluency in school-aged children. Another study of semantic fluency failed to reveal effects of gender on the tasks of semantic fluency in adults (Gawda & Szeptowska, 2013). In line with this finding is a one, already mentioned, large meta-analytic study concluding no differences in verbal abilities exist in relation to the gender (Hyde & Linn, 1988). However, on the other hand, many studies found female advantage in verbal fluency tasks and the greater ability of females to switch among the categories (Weiss et al., 2006).

It would be very useful to replicate our study in school aged children, adolescents and adults using several semantic categories. This would help us elucidate further developmental language trajectory and role of gender in the tasks of verbal fluency. We believe, in line with this study's finding, that probably no gender differences exist for easier semantic categories (containing more items), but they start to appear for more difficult semantic categories (containing fewer items). This claim needs to be confirmed or repudiated in future studies.

The outcome measure used in this study was the number of retrieved words for each of the semantic categories. There are different strategies children can use to retrieve as many words as possible to complete this task. For example children might use clusters of similar items in a category, for example in the category food, they can first name fruit items and then switch to vegetables. This cognitive action involves, besides working memory, another executive function component and that is shifting. Shifting refers to the ability to move freely from one aspect of a problem to another and to solve problems flexibly (Gioia, Isquith, Guy, & Kenworthy, 2000). In other models of executive functions shifting is referred to as attentional flexibility (Hughes, 1998). Children with autism spectrum disorder, for example, tend to produce more words in the same cluster but at the same time are less likely to switch between different clusters (Begeer et al., 2014).

We did not analyse features of responses, such as lexical organization and how preschool children are clustering words, and this should be the topic of future studies on the subject. Overall, examination of the effects of age and gender on other neuropsychological and psychological constructs is a frequent topic in research. For example, there are studies examining their influence on executive functions (Thorell, Lindqvist, Bergman Nutley, Bohlin, & Klingberg, 2009), finger tapping speed (Memisevic et al., 2017), peer relations (Gülay, 2011), inhibitory control (Macdonald, Beauchamp, Crigan, & Anderson, 2014), theory of mind. Current study added semantic fluency task to this list of topics that were explored in relation to the child's age and gender.

Let us mention couple of limitations of this study. We only examined the effects of two variables on the outcome. There are many other factors that contribute to the semantic fluency performance. For example, environmental factors have a large influence on semantic fluency performance in preschool children (Kavé, Shalmon, & Knafo, 2013) and were not examined in this study. Besides environmental factors, there are other factors that were not included as covariates in this study such as executive functions, intelligence, vocabulary. Further elucidation of their link with semantic fluency, in addition to age and gender, would help us in better understanding the development of semantic fluency. Also, as the children in this study were from public kindergartens, there might be different trends in children from private kindergartens, as there are probably differences in socio-economic status. Further let us mention the use of semantic fluency tests as they are not without critics. Some authors question its ecological validity in everyday contexts, as well as methodologies employed in

the assessment of the construct of semantic fluency, as they almost always contain some level of interactional variation (Muskett, Body, & Perkins, 2013).

As this was an exploratory study we did not have any established norms for these semantic tasks. However, it would be very useful to establish verbal fluency norms on a larger sample of preschool children in Bosnia and Herzegovina. This in turn will help educators identify disadvantaged children at an early age and help to provide them early language enrichment programs.

Finally, let us briefly mention some of the interventions that can contribute to the improvement of child's semantic fluency. Given its importance, the preschool curricula should emphasize the activities not only aimed at increasing the child's vocabulary but also at expanding the semantic richness of their lexical representation (Wechsler-Kashi, Schwartz, & Cleary, 2014). Some new methods and approaches, such as multi-tiered interventional framework have shown its efficacy in improving language skills in preschool children (Zucker, Solari, Landry, & Swank, 2013). Learning second language can also be beneficial as it increases sensitivity to structural properties of language (Bree, Verhagen, Kerkhoff, Doedens, & Unsworth, 2016). Parents should also be encouraged and informed about the positive effects of verbal interactions with children. Studies have shown that richer early language experience positively impacts language growth (Weisleder & Fernald, 2013).

Given the rapid growth in semantic fluency in preschool children, it is very important to actively promote its development in early years.

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Competing Interests

The authors declare no competing interest.

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