SUMMARY

Background: Verbal fluency (VF) is a good indicator of a child’s academic prowess and later academic success. The goal of the present study was to examine the association between VF and inhibitory control. An additional goal was to examine the developmental trajectories of VF in relation to the grade and gender of the children.

Material/Methods: The sample for this study consisted of 210 children attending grades 1 to 3. Children’s performance was measured on two VF tasks: semantic fluency and phonological fluency. As a measure of inhibitory control we used a number of commission errors committed on the Multiple Choice Reaction Test. The results of this study indicate the lack of association between VF and inhibitory control. Children improved significantly in VF from grade 1 to grade 3. In relation to gender, girls outperformed boys on the test of phonological fluency but not on the test of semantic fluency.

Conclusions: Given the importance of VF, these skills need to be tackled during the elementary school period and even earlier in preschool.

Key words: verbal fluency, elementary school children, inhibitory control, academic success.
INTRODUCTION

Verbal fluency (VF) is a good indicator of a child’s verbal ability and executive control. In particular, VF is related to a child’s lexical knowledge and lexical retrieval ability. VF can be defined as an ability to retrieve words from the memory in an organized way (John & Rajashekhar, 2014). As a measure of overall verbal skills, VF is a good indicator of a child’s academic prowess and later school success. There is a link between VF and many other cognitive processes, in particular with executive functions (EF). EFs is a set of higher cognitive skills responsible for many everyday activities and abilities including planning, cognitive flexibility, inhibitory control, and working memory (Memisevic & Sinanovic, 2014). Thus, VF assessment is often used in neuropsychology and that assessment is an integral part of neuropsychological assessment (Harrison, Buxton, Husain, & Wise, 2000; Shao, Janse, Visser, & Meyer, 2014). Studies on VF have covered a wide range of topics. In relation to age range, VF has been examined in populations varying from preschool children (Memisevic, Biscevic, & Pasalic, 2017) to adult populations (Shao et al., 2014). Further, VF has been the subject of inquiry in a number of clinical populations, e.g., in people with Alzheimer’s disease (Mueller et al., 2015), Parkinson’s disease (Roesch et al., 2016), and Huntington’s disease (Wahlin et al., 2015). Given its potential to indicate a child’s developmental level, VF tests have also been widely used in children with developmental disabilities. For example, Wang and Bellugi (1993) assessed VF in children with Williams and Down syndrome, and many studies have examined it in children with autism spectrum disorder (Kleinhans, Akshoomoff, & Delis, 2005; Turner, 1999).

VF is a complex process in its own right. The brain areas most activated during the VF tasks are Broca’s area and the dorsolateral prefrontal cortex (Gaillard et al., 2000). According to these authors, children’s activation of the cortex during these tasks is more widely distributed in comparison with adults, and activation patterns for fluency are established by middle childhood. The assessment of VF usually consists of two tasks: a semantic fluency task and a phonological fluency task. The semantic fluency task assesses the verbal knowledge of a certain category (e.g., animals), and is also referred to as categorical fluency. On the other hand, phonological fluency examines verbal knowledge through the number of words produced starting with a particular letter (m for example). Phonological fluency is also referred to as letter fluency. In both tasks, the usual procedure is to ask participants to produce as many words in one minute.

Many studies have examined developmental changes in VF in school-aged children. Not surprisingly, these studies have found a positive correlation between age and VF performance (Riva, Nichelli, & Devoti, 2000; Pawlicka, Lipowska & Jurek, 2018). However, studies have pointed that a linear relationship between age and VF exists up to a certain age after which it begins to decline. The most commonly reported age cut-off point at which children reach the adult level of production in VF is around 10 years of age (Regard, Strauss, & Knapp, 1982).

We have already mentioned that VF is related with executive functions (EF)
and there is a plethora of research examining the effects of executive functions on verbal fluency. However, the majority of the studies examining the link between VF and EF were aimed at clinical populations (Abrahams et al., 2000; Joyce, Collinson, & Crichton, 1996) and only a few studies dealt with preschool and school children (Koren, Kofman, & Berger, 2005; Biscevic, Pasalic, & Memisevic, 2017).

An executive function that was of interest to us in this study was inhibitory control, which can be defined as an ability to control thought processes and actions that can potentially interfere with the individual’s goal (Carlson & Wang, 2007). Previous studies have indicated a lack of relationship between inhibitory control and the task of semantic fluency in preschool children (Memisevic & Biscevic, 2018). In line with this, the lack of inhibitory control effect on verbal fluency has been noted in older populations as well (Shao et al., 2014). However, the effects of inhibitory control on VF in school-aged children remain unknown. Thus, given the relative paucity of this kind of research in children, we wanted to examine the effects of inhibitory control on VF in children grades 1-3. In addition to this, we examined the trajectory lines of VF in relation to the child’s gender and child’s grade.

The specific hypotheses set in this study were:

- There is no significant effect of inhibitory control on VF tasks;
- There is a statistically significant improvement in VF tasks from grades 1 to 3;
- There are no statistically significant differences in VF tasks in relation to the children’s gender.

MATERIAL AND METHOD

Participants

The sample for this study consisted of 210 children (103 girls, 107 boys) attending first, second, and third grade of two elementary schools in Sarajevo city. There were 70 children (36 girls, 34 boys; mean age 80.9 months, SD- 3.1 months) attending the first grade, 70 children (34 girls, 36 boys; mean age 92.1 months, SD- 3.6 months) attending the 2nd grade and 70 children (33 girls, 37 boys; mean age 103.1 months, SD- 5.6 months) attending the 3rd grade. According to the teachers’ reports the children were free of any developmental disability or other neurological condition.

Measures

Verbal fluency was assessed by two tasks, a semantic fluency task and a phonological fluency task.

1. Semantic fluency task

Numerous studies examining language and the relationship between language and executive functions have used semantic fluency as an independent
variable. In this study we used the semantic category of animals. Children were asked to name as many animals as possible in 60 seconds. The total number of named animals was used as a predictor variable.

2. Phonological fluency task

Another test of verbal fluency we used in this study was phonological fluency. The procedure is the same as for the semantic fluency task only this time children needed to only name as many words as possible in 60s starting with the letter M.

Inhibitory Control- Commission errors

The task used for the assessment of Inhibitory Control was a computerized Multiple-Choice Reaction Time Test (Di Nuovo, 2000). In this test, children are required to press the space button on a computer every time they see a star appearing on the screen and to inhibit the response when they see any other object appearing on the screen (go-no/go paradigm). The total number of stimuli presented was 45, out of which 9 are targets. The stimuli were presented randomly to children. The computer program used for this assessment was Attenzione e concentrazione (Di Nuovo, 2000) and had been used previously for measuring inhibitory control in preschool children (Memisevic & Biscevic, 2018). There are four outcome measures on this test: the number of correct answers, the mean reaction time, the errors of omission and the errors of commission. For the purposes of this study we only present the number of commission errors committed as a measure of inhibitory control. Commission errors are seen as a measure of inhibitory control. The other three measures, are regarded as the measures of attentional control and were not used in this study.

Procedure

We selected two elementary schools in Canton Sarajevo and provided teachers with the consent forms for the children’s parents. Although the schools were not randomly selected, we have no reason to believe that they are in any way different from the rest of the schools in Sarajevo Canton. After the consent forms were returned, we tested the children on the tests described above. We tested a total of 210 children (70 children who were attending first grades, 70 children from second grades and 70 children from third grades). All the children were tested individually, in the morning hours, in the classrooms that were available for the testing. 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 written parental consent were tested. The current study is part of a larger study on the predictors of academic achievements of school-aged children. Results on the predictors of math achievement have already been published (Memisevic, Biscicvic, Pasalic, 2018).
Statistical analysis

For the first research question we calculated the Pearson correlation coefficient between inhibitory control and verbal fluency. We also presented descriptive results on VF (means and standard deviations) for 1st, 2nd, and 3rd grade students of both boys and girls. To answer the second research question we performed a two-way analysis of variance (ANOVA). An alpha level of .05 was used for all the statistical tests.

RESULTS

Our first hypothesis was that there was no effect of inhibitory control on verbal fluency. The correlation between the inhibitory control and both semantic fluency and phonological fluency was low and statistically insignificant for the whole sample of children. These correlations are shown in Table 1.

These low correlations between inhibitory control and VF tasks were present across the grades.

We next present the descriptive results on VF tasks in relation to a child’s grade and gender in Table 2.

As can be seen from Table 1, there is an improvement in both semantic and phonological fluency from Grade 1 to Grade 3. On average, the improvement from Grade 1 to Grade 3 in semantic fluency was about 26%, while the same improvement for phonological fluency was 45%. Looking separately, the largest improvement was from Grade 1 to Grade 2, for semantic fluency, the improvement was 20% and for phonological fluency it was 38%. The improvement in semantic fluency from Grade 2 to Grade 3 was 8% and for phonological fluency it was 11%. However, as this is a cross-sectional study, this improvement in % should serve only as a guideline.

Table 1. Correlation between inhibitory control and verbal fluency

<table>
<thead>
<tr>
<th></th>
<th>SF</th>
<th>PF</th>
<th>INH_CON</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF</td>
<td>1.00</td>
<td>.52**</td>
<td>-.11</td>
</tr>
<tr>
<td>PF</td>
<td>-</td>
<td>1.00</td>
<td>-.05</td>
</tr>
<tr>
<td>INH_CON</td>
<td>-</td>
<td>-</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Note. **p<.01; SF- semantic fluency, PF-phonological fluency, INH_CON- inhibitory control

Table 2. Means and standard deviations on verbal fluency tasks for a child’s grade and gender

<table>
<thead>
<tr>
<th>Group</th>
<th>Semantic fluency</th>
<th>Phonological fluency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Grade/gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>9.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Boys</td>
<td>9.9</td>
<td>2.1</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>12.2</td>
<td>4.1</td>
</tr>
<tr>
<td>Boys</td>
<td>12.0</td>
<td>4.4</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>14.0</td>
<td>4.7</td>
</tr>
<tr>
<td>Boys</td>
<td>12.3</td>
<td>4.3</td>
</tr>
</tbody>
</table>
We next performed a two-way ANOVA test to determine whether the gender, grade and their interaction had a significant effect on verbal fluency. In Table 3 and 4 we present the results of the two-way ANOVA for semantic fluency and phonological fluency respectively.

As can be seen from Table 3, grade but not gender had a significant effect on semantic fluency. We can conclude that the performance on semantic fluency statistically significantly improved from 1st to 3rd grade.

As can be seen from Table 4, this time both grade and gender had a significant effect on phonological fluency. Obviously again, the performance on phonological fluency statistically significantly improved from 1st to 3rd grade. In addition to this, the difference between girls and boys on the task of phonological fluency was statistically significant. Girls outperformed the boys in all grades from 1-3, and the largest difference was in the 3rd grade.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1</td>
<td>13.1</td>
<td>13.1</td>
<td>.81</td>
<td>.37</td>
</tr>
<tr>
<td>Grade</td>
<td>2</td>
<td>440.8</td>
<td>220.4</td>
<td>13.6</td>
<td>.001</td>
</tr>
<tr>
<td>Gender*Grade</td>
<td>2</td>
<td>42.3</td>
<td>21.2</td>
<td>1.3</td>
<td>.27</td>
</tr>
<tr>
<td>Within cells</td>
<td>204</td>
<td>3309.5</td>
<td>16.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>209</td>
<td>3797.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Summary of two-way ANOVA for grade and gender effect on phonological fluency

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1</td>
<td>41.7</td>
<td>41.7</td>
<td>7.2</td>
<td>.01</td>
</tr>
<tr>
<td>Grade</td>
<td>2</td>
<td>360.1</td>
<td>180.1</td>
<td>31.2</td>
<td>.001</td>
</tr>
<tr>
<td>Gender*Grade</td>
<td>2</td>
<td>23.7</td>
<td>11.8</td>
<td>2.1</td>
<td>.13</td>
</tr>
<tr>
<td>Within cells</td>
<td>204</td>
<td>1178.7</td>
<td>5.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>209</td>
<td>1593.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION

The goal of the present study was to examine the association of verbal fluency and inhibitory control. In addition to this, we examined the development of VF in relation to the child’s gender and child’s grade. We found no significant association between VF and the inhibitory control. This finding is in line with previous studies conducted with preschool children and older adults (Memisevic & Biscevic 2018; Shao et al., 2014). This study provides an additional piece of evidence that VF is not dependant on inhibitory control measures in a novel sample of school-aged children.

As for the developmental trends in VF, the improvement across grades is obvious for both, semantic fluency and phonological fluency tasks. The improvement is particularly evident from Grade 1 to Grade 2, and from Grade 2 to Grade 3 the improvement is somewhat slower. This finding is in line with earlier studies that indicated that children reach an adult level of performance at the age of 10 (Regard et al., 1982). However, as the rate of improvement varied depending on
the VF task, it remains an open question as to whether semantic fluency and phonological fluency reach their plateau at the same time.

Our last research question dealt with the gender effects on VF. In the semantic fluency task, performance was similar across the grades in boys and girls as there were no statistically significant differences between them. However, a different trend was evident in the phonological fluency task. Girls outperformed boys in all grades and the difference was statistically significant. This difference was particularly evident in Grade 3. There are several potential explanations for this finding. It is well-known that there are different neural correlates for the semantic fluency and phonological fluency tasks. Although they appear similar, there are a number of differences between these two tasks. Semantic fluency tasks resemble everyday production tasks in which participants use associations between related concepts, while in phonological fluency participants must suppress the activation of related words and must use novel strategies for word retrieval (Shao et al., 2014). Given that the males and females use different processing strategies in VF tasks (Weiss et al., 2006) and that the brain activity in language tasks is more diffuse in females (Shaywitz et al., 1995), might be the reason why the girls had outperformed boys in this task. Of course, it is possible that the differences in performance were sample-specific but this explanation is unlikely as there were not differences in the semantic fluency task.

To our best knowledge, this is the first study examining the developmental trends in VF in school-aged children in Bosnia and Herzegovina. Besides its theoretical contribution, we believe this study has important practical implications as well. VF is a good reflection and indicator of the vocabulary size, which, in turn, is related to academic outcomes (Sauzeon et al., 2011). VF is also a great predictor of reading ability. Therefore, VF development is related to many positive academic achievements. The results of this study showed that Grade 1 is particularly important for the development of VF. Given the large number of children from disadvantaged families and children with developmental disabilities such as Autism Spectrum Disorder who enroll into regular schools, it is particularly important to have well-trained and well-prepared teachers to educationally support these children (Dizdarevic, Mujkanovic, & Memisevic, 2017; Mujkanovic et al., 2017). Thus, teachers need to be aware of the instructional strategies that promote VF. Increasing children’s interest in reading and developing children’s vocabulary are some of the proven strategies to improve language (Kasper, Uibu, & Mikk, 2018). As is the case for many other developmental areas, early learning has a tremendous effect on children’s language skills. High quality early education has a huge effect on fostering children’s school readiness and success (Castro et al., 2011). Early developmental programs have a particularly important role for children from low-income backgrounds in fostering their language development (Dickinson, 2011). Educators (preschool and early grades) are the key stakeholders in the endeavor to improve language skills. In line with this and given their importance, educators need to have permanent professional development so they can be familiarized with new instructional methods. In addition to educators, parents, as
children’s first teachers, also have an important role to play in promoting children language skills (Reese, Sparks, & Leyva, 2010). Educators can empower parents in a way to teach them some of the educational strategies that improve language skills.

Let us mention some of this study’s limitations. First of all, as we used only one measure of inhibitory control, namely the Multiple Choice Reaction Time Test, it is possible that we did not capture the broader aspect of inhibitory control. Future studies should take into consideration a wider arsenal of instruments for assessing the whole concept of inhibitory control. Secondly, we only used one category in the semantic fluency test (animals) and only one letter in the phonological fluency test (letter M). It is possible that different trends might appear for the more difficult categories and letters (for example, the category: musical instruments and the letter: F). In future studies, researchers are advised to experiment with different categories and letters to see if the developmental trend in VF follows the same pattern as the one described in this paper. It is possible that the sample of children in this study was not fully representative of all the children attending Grades 1 to 3.

ACKNOWLEDGEMENTS

This study was partially funded by the Canton Sarajevo Ministry of Education as part of the project “Executive functions in early grades elementary students”. We would like to thank all the children, parents and teachers who helped us in implementing this research.

REFERENCES:


Memisevic et al., Inhibitory control in children


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