THE EFFECTS OF EXECUTIVE FUNCTIONS AND THEORY OF MIND ON SEMANTIC FLUENCY IN PRESCHOOL CHILDREN

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Abstract

Semantic fluency (SF) is a suitable indicator of preschool verbal abilities and can be used as a predictor of later school success. This research examined the effects of executive functions (EF) and theory of mind (TOM) on semantic fluency in preschool children. Dimensional Card Sorting test was used as an instrument of executive functions and the Sally-Anne test was used as a measure of theory of mind. The sample for this research comprised 116 preschool children, 60 boys, 56 girls, aged 38-72 months. The results of this research revealed a statistically significant effect of EF on SF (p=.03). The effect of TOM on SF was statistically non-significant, although approaching statistical significance (p=.06). There were no interaction effects of EF and TOM on SF. Findings of this research strongly suggest the need for EF training activities in preschool children. Preschool institutions of 21st century need to have curricula aimed at fostering EF skills.
Keywords: *semantic fluency, executive functions, theory of mind, preschool children.*

Introduction

Preschool period is very important for child's development as the rapid growth in many developmental areas including language, cognitive skills, motor skills, emotional skills etc. take place in this period. Language skills at preschool age are a very good predictor of later academic achievement (Duncan et al., 2007; Rohde & Thompson, 2007; Young et al., 2002). Thus, the assessment and treatment of early language skills is of paramount importance at preschool age. There are numerous studies showing what are the predictors of good language skills at preschool age. Most research in this area have identified the importance of family factors such as socio-economic status, parent's level of education and family history as factors of crucial importance in child's language development (Heath et al., 2014). In addition to this, a plethora of studies pointed to cognitive and emotional factors within the child that are identified as being related to the language acquisition (Bohlmann & Downer, 2016; Inoue et al., 2017). Given its importance and predictive validity in relation to academic achievement, assessment of certain aspects of language, such as verbal fluency provides a useful insight into the cognitive functioning of the individual (Memisevic, Biscevic, & Pasalic, 2017).

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Verbal fluency, consisting of semantic and phonological fluency, is often regarded as a measure of language as well as a measure of executive functions. Some recent studies have shown that verbal fluency tasks are, to a larger extent correlated with language than they are with executive functions (Whiteside et al., 2015). Verbal fluency is usually assessed with two types of tasks: tasks of phonological fluency and tasks of semantic fluency. Phonological fluency tasks involve production of words starting with a particular letter (for example, words starting with letter "M") and semantic fluency tasks involve a production of words that belong to a certain category (e.g. "animals"). Semantic fluency is a measure of both, verbal fluency and cognitive flexibility, and it is more appropriate to use semantic fluency tests with younger children than phonological fluency tests (Welsh, Pennington, & Groisser, 1991). It would be very useful to examine what are the factors that have an influence on development of semantic fluency in preschool children, as this can be very informative for creation of new curricula that would foster this segment of language development. Current studies dealt with demographic predictors of semantic fluency, such as age and gender (Memisevic, Biscevic, & Pasalic), but did not consider the effects of cognitive processes, such as executive functions and theory of mind on the semantic fluency.

Thus, the aim of this research was to examine the effects of executive functions and theory of mind development on semantic fluency.

Executive functions (EF) are a complex cognitive construct composed of several components such as working memory, cognitive flexibility and inhibitory control. EFs are one of the most researched topics in child neuropsychology, given their importance in explaining the typical and atypical child development. Especially prominent have been the studies connecting the concept of EF with certain developmental psychopathologies such as Attention Deficit Hyperactivity Disorder, autism, Tourette syndrome, and conduct disorder (Pennington & Ozonoff, 1996). EFs have been studied widely in children with developmental disabilities (Costanzo et al., 2013; Griffith et al., 1999; Memisevic & Sinanovic, 2014). In comparison to the vast interest in the development of EFs in children with developmental disabilities, development of EF in typically developing children, especially at a younger age, has received much less attention (Hughes, 1998). According to Hughes (1998), a possible reason for this is that most EF tasks are too difficult for use with younger children. Thus, as the measure of executive functions we used a Dimensional Card Sorting Test, as this test is easily administered, widely used and can be reliably used with preschool children. This particular test assesses the flexible use of rules to govern behavior, which is a crucial aspect of executive functions (Zelazo, 2006).

Besides EF, another construct that has a rapid development at preschool age is the concept of Theory of Mind (TOM). TOM can be defined as the ability to impute mental states to oneself and others and these mental states include thoughts, feelings, intentions and beliefs (Premack & Woodroof, 1978). TOM is very important for the development of social skills and can help in creating meaningful social relations (Baron-Cohen, Leslie, & Frith, 1985; Wichstrom, Belsky, & Berg-Nielsen, 2013). As the measure of TOM we used Sally Anne test (Baron-Cohen et al., 1985).

Within the scope of the research aim, the specific goals of the research were to examine the main effects of EFs and TOM as well as their interaction effect on semantic fluency.

Methodology of Research

General Background

This research was implemented between September 2016 and March 2017. It was part of the larger project entitled *Executive Functions in Preschool Children in Canton Sarajevo.* Some findings from this project, regarding the effects of age and gender on semantic fluency and finger tapping speed have already been published (Memisevic et al., 2017a; Memisevic et al., 2017b). An observational (correlational) design was used as a research method.

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Research Sample

The sample for this research consisted of 116 preschool children aged 3 to 6 years (mean age=58.8 months, SD= 9.5 months). There were 56 girls (48.3%) and 60 boys (51.7%) in the sample. There were no statistically significant differences in the mean age between boys and girls (t=0.36; p=.72). Children were attending public preschool institutions in Canton Sarajevo, Bosnia and Herzegovina. According to their educational records, all children were free of any known neurological and/or psychiatric condition or developmental disability.

Research Procedure

Children were recruited from 8 small-sized public kindergartens in Canton Sarajevo. The goals of the research were explained to the preschool teachers and parent consent forms were distributed. Consent forms contained all the information regarding the research. After the consent forms were returned (out of 200 consent forms, 158 were signed and returned, 79% response rate), children were tested on a number of tests (see *Measures*). 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 (separate office) at the kindergartens. The complete testing session lasted approximately 20 to 25 minutes for each child. Some children were sick at the time of testing (n=15) or did not want to do the tests (n=10), or the testing data were incomplete (n=17). The final sample consisted of 116 children from these 8 kindergartens for who the complete data were obtained for the measures needed for this research. The approval for this research 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.

Instruments

Semantic Fluency tasks. In this task children were asked to name as many words in 60 seconds belonging to a category of animals, as the animals were the most researched category in these tasks. The number of retrieved words was used as an outcome variable in this study.

Dimensional Card Sorting Test was used as a measure of Executive Functions. The protocol for this test has been described in great detail in a paper by Zelazo (2006). The border version of the task was used in this research. Children are asked to sort the cards according to a predefined rule (color or shape). On each trial children are told what to do. The outcome of the test is categorical: pass or fail.

Sally-Anne false – belief test is a widely used test for assessing the theory of mind. It is explained in numerous studies (Wimmer & Perner, 1983; Baron-Cohen et al., 1985). In this research the dolls named "Emina" and "Maja" who were playing with the ball and two boxes (red and blue) were used for this task. The researchers explained to the child how the dolls played together and placed a ball under the red box. After they placed the ball under the red box, Emina exited the room. In the meantime, Maja switched the position of the ball from under the red box to the blue box. Emina returned to the room and the child was asked where will Emina look for the ball, under which box? The outcome of this test was also categorical: "pass" or "fail", and this result was used as an explanatory variable. The correct answer was recorded only if the child was able to explain why Emina will look for the ball under the red box. The original task did not ask children to justify their response. However, in this research, the justification was

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asked of children because without explanation 50% of children might have guessed the correct answer by chance alone.

Data Analysis

The dependent variable in this research was the result on semantic fluency test and independent variables were the categorical outcomes on Dimensional Card Sorting Test and Sally-Anne test (pass/fail). A two-way ANOVA was performed to examine the effects of independent measures of EF and TOM on semantic fluency. Data were analyzed with the computer program SPSS for Windows (v.13). For all tests, an alpha level (the probability of rejecting a null hypothesis when it is in fact true) of statistical significance was set at $p<.05$.

Results of the Research

First the mean values are presented on semantic fluency test in relation to the results of EF and TOM tests. These results are presented in Table 1.

Table 1. Means and standard deviations of semantic fluency task as a function of EF and TOM outcomes.

Task	Pass		Fail	
	M	SD	M	SD
Executive functions	8.6	3.5	6.9	3.0
Theory of mind	8.7	3.7	7.1	3.1

As can be seen from the table 1. higher mean scores on semantic fluency were achieved by children who were successful (pass) on tests of executive functions and theory of mind.

The results of two-way ANOVA are presented in Table 2.

Table 2. Summary of two-way ANOVA for Executive Functions and Theory of Mind.

Source	df	MS	F	p
Executive Functions	1	50.2	4.87	.03
Theory of mind	1	37.5	3.64	.06
EF * TOM	1	0.21	0.21	.88
Residual	112	10.3		

According to the two-way ANOVA test, there was a significant effect of EF on semantic fluency test. TOM was not statistically significant, but this value needs to be interpreted cautiously as it almost reached statistical significance. The table also shows lack of interaction effects of EF and TOM on semantic fluency.

To gain a better insight into the associations between EF and TOM, and semantic fluency, the sample was divided into four categories depending on their result on EF and TOM tests (shown below):

1st category- Card Sort: Failure; TOM: Failure
2nd category- Card Sort: Failure; TOM: Pass
3rd category- Card Sort: Pass; TOM: Failure

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4th category- Card Sort: Pass; TOM: Pass

The mean Semantic fluency scores in relation to the category are presented in Table 3.

Table 3. Mean scores on semantic fluency test in relation to the category.

Category	N	Mean	Std Error	Lower 95%	Upper 95%
1	57	6.58	0.42	5.73	7.42
2	16	8.0	0.80	6.41	9.59
3	29	8.21	0.60	7.02	9.39
4	14	9.42	0.85	7.73	11.13

It is obvious that children who passed both EF test and TOM test achieved the best results on semantic fluency test. An ANOVA test was performed to see if there are statistically significant differences in relation to these four categories (Table 4).

Table 4. One-way analysis of variance for semantic fluency.

Source	DF	Sum of Squares	Mean Square	F	p
Between groups	3	118.84	39.6	3.84	.012*
Within group	112	1156.08	10.3		
Total	115	1274.92			

As can be seen from Table 4. there were statistically significant differences in relation to the category. A post hoc test was performed to examine what categories are different from each other. As the assumption of homogeneity of variance was not violated (Levene p= .25), but the groups were unequal in size, we used Hochberg's GT2 post hoc test (Field, 2005). According to the test, the only significant difference was between the 1st and 4th category (p=.021). Children who passed both, EF and TOM test achieved statistically higher mean scores on semantic fluency than children who failed both these tests.

Discussion

The aim of the present research was to examine the effects of EF and TOM on semantic fluency. The results indicate that both constructs have the effects on semantic fluency, although the EF was statistically significant, and TOM was slightly outside the margins of statistical significance. These results indicate that EF has a stronger effect on semantic fluency than TOM. There were no interaction effects of EF and TOM on semantic fluency. This research confirms earlier research that showed the impact of EF and TOM on certain language components. In a study by Sesma et al. (2009), the authors found that EF makes a significant contribution to reading comprehension but not to word recognition skills. EFs seem to affect the optimal use of processing capacity in language tasks (Im-Bolter, Johnson, & Pascual-Leaone, 2006). As for the studies regarding the effects of TOM on language development, there are many studies examining this link. However, the exact nature of this link has been hotly debated (Milligan, Astington, & Dack, 2007). The main question in this field has been, is it language that predicts TOM performance or vice versa. Current findings have established a stronger link for language skills predicting TOM than vice versa (Astington & Jenkins, 1999; Milligan, Astington, &

Dack, 2007), which is in line with a claim that language is fundamental to TOM development. It is safe to say that children who have developed TOM have better semantic fluency skills than children who do not have developed TOM.

The findings of this research have important implications for the preschool practice. As one of the main goals of preschool education is language development, we can see that EF and TOM training could foster language development. Thus, it is of utmost importance to offer different curricula in preschool institutions that would take into consideration the importance of EF and TOM. There are numerous studies showing the potential of EF and TOM improvement through training at an early age. For example, specific curricula such as the Tools of the Mind have been shown to improve EF (Diamond et al., 2007), which in turn has a positive impact for the overall academic success. Another type of training called *Reflection Training* has also been shown to improve EF in preschool children (Espinet, Anderson, & Zelazo, 2013). As for the TOM, it has been shown, that training on the concept of belief led to better TOM performance in preschool children (Slaughter & Gopnik, 1996). However, there are some studies that investigated whether the effects of trainings on TOM tasks can be generalized to improve language skills. One such study by Hale and Tager-Flusberg (2003) showed that false-belief training contributes to better TOM scores but has no effect on language skills.

Most studies that examined the relationship between EF, TOM and language skills involved clinical samples such as people with schizophrenia, Alzheimer's disease etc. (Greene, Hodges, & Baddeley, 1995; Joyce, Collinson, & Crichton, 1996). Literature is scant examining the effects of EF and TOM on language development in preschool children. This is the first study, to the best of author's knowledge, to examine the effects of EF, TOM and their interaction on semantic fluency in preschool children. Several limitations need to be noted. Both, EF and TOM are dimensional in nature, they are not categorical in the sense that the child either has them or not. However, in this study we regarded them as categorical variables, the child either passed or failed these tests. Future studies should take into consideration continuous measures of EF and TOM and their relationship to semantic fluency. Next, we did not account for age effects. It is likely the case that children who passed both tests (EF and TOM) were older than children who failed both tests. However, as the goal was to explore the relative influence of EF and TOM on semantic fluency this was of secondary importance.

Conclusions

Preschool period is very important for the development of language, executive functions and theory of mind. This research has shown that there are strong effects of executive functions and theory of mind on semantic fluency. This research provided more details about the nature of this link, in particular the effects of executive functions and theory of mind on development of semantic fluency in children. It is important to point that preschool institutions need to modernize their curricula taking into account the results of scientific research in this area. A particular attention should be given to executive functions training at preschool age as it is shown to have many positive benefits for later academic success including the development of semantic fluency. Given the significance of semantic fluency for children's academic skills, this improvement in semantic fluency will lead to better academic outcomes in children.

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