Acquisition of the theory of mind (TOM) is a very important milestone in the development of preschool children. TOM is especially important for the development of children’s social skills. The goal of the present study was to examine the effects of age, gender and executive functions (EF) on the acquisition of TOM.

The sample in this study consisted of 116 preschool children aged 36-72 months (mean age 58.8 months, SD=9.5 months). In relation to the child’s gender, there were 56 girls (48.3%) and 60 boys (51.7%). The Sally Anne test- a task purporting to measure TOM, was used as a dependant variable and age, gender, and EF measures were used as the predictors.

Logistic regression was used as a method to determine the effects of predictors on TOM. The results of this study indicated that success on the TOM test can best be predicted by the inhibitory control, followed by verbal fluency and child’s age. The gender of the child was not associated with TOM acquisition. The overall model explained between 27% and 38% of the variance in the TOM scores.

Inhibitory control is the executive function that had the greatest predictive power for the results on the theory of the mind task. The findings of this study can help early interventionists in the modification of existing preschool curricula, so that they include more activities that would foster the development of the theory of mind in preschool children. Future studies should aim to find a better model of theory of mind predictors by examining the effects of other executive function constructs, such as working memory.

Key words: theory of mind, preschool children, executive functions, inhibitory control, age and gender effects
The theory of mind 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; Leslie, Friedman, & German, 2004). Defined in such a way, the theory of mind is of crucial importance for the development of social skills (Baron-Cohen, Leslie, & Frith, 1985). In fact the theory of mind is the foundation for humans’ ability to participate in complex social interactions (Stone, Baron-Cohen, & Knight, 1998). Well developed social skills are the prerequisite for developing meaningful social relations and can protect against anxiety disorders in preschool years (Wichstrom, Belsky, & Berg-Nielsen, 2013). In addition to this, the theory of mind is also associated with some other positive traits such as fairness (Takagishi et al., 2010). Children who have developed the theory of mind are more likely to act prosocially (Imuta et al., 2016).

Some authors have proposed that the development of the theory of mind is a precondition for developing higher levels of executive functioning (Perner & Lang, 2000). In fact, executive functions and the theory of mind are connected in many ways (Carlson, Claxton, & Moses, 2015). The exact nature of this relationship is not quite clear and it is hard to delineate whether the development of executive functions causes better performance on theory of mind tasks or vice versa. In fact, there are a few studies that specifically dealt with this issue and the results of these studies provide much more support for the notion that EF skills are a prerequisite for the development of TOM (Moses, Carlson, & Sabbagh, 2005). For example, in a study by Hughes and Ensor (2007), the authors found partial support for the notion that the theory of mind is a prerequisite for executive functions and reported much stronger support for the idea that executive functions in fact facilitate children’s performance on theory of mind tests. Similar conclusions were reached in a study by McGlamery et al. (2007), where the authors also found that executive functions, along with attention were predictive of theory of mind test scores and in a study by Goukon et al. (2006) the authors concluded that executive functions are important for understanding false beliefs.

Given its importance for many social skills and executive functions, it is very important to acquire the theory of mind in one’s early years. Preschool years are the period when children develop their theory of mind, while its developmental trajectories are similar across many cultures (Sabbagh et al., 2006). There is a developmental link in preschool years between the acquisition of the theory of mind and self control (Perner & Lang, 1999; Goukon et al., 2006). The age at which children acquire the theory of mind is somewhere between 4 and 5 years of age (Wright & Mahfoud, 2012). This age range is an approximation for typically developing children as children with developmental disabilities, particularly children with autistic spectrum disorder may have difficulties in acquiring the theory of mind (Baron-Cohen et al., 1985). Younger children, at the age of 3 years, are very poor at appreciating other people’s view of the world (Frye, Zelazo, & Burack, 1998).
There are a number of factors associated with the acquisition of the theory of mind. One already mentioned above is executive functions. Besides executive functions, there are many other factors that play a role in theory of mind development, with language certainly one of the most researched factors. Some of the findings exploring the link between language and the theory of mind found that earlier language abilities are correlated with better theory of mind outcomes. Greater phonological storage is found to be associated with a better theory of mind (Wynn & Coolidge, 2009). Researchers have also found that fluid intelligence has an effect on the theory of mind in secondary school students (Ibanez et al., 2013). Working memory is yet another factor found to be related and predictive of the theory of mind (Mutter, Alcorn, & Welsh, 2006).

As the Executive Function construct is a complex one and has several components, we wanted to examine the relationship of several EF components with TOM. The EF measures used were inhibitory control, cognitive flexibility. According to most executive functions models, inhibitory control is a component of executive functions (Gioia, et al., 2002) and it was assessed with a multiple reaction time test. As the measure of cognitive flexibility we used three semantic fluency tasks. Semantic fluency tests are more appropriate for use with younger subjects than orthographic fluency tests (Welsh, Pennington, & Groisser, 1991). We wanted to find out whether the relationship between semantic fluency and TOM is the same across the different difficulty levels of semantic categories, thus we used three semantic categories that vary in difficulty: animals, food and musical instruments. In addition to these two tasks of executive functions, we also examined the relationship of gender and age with TOM and all these factors were used as explanatory variables for TOM acquisition.

The acquisition of TOM is usually assessed through the false-belief tasks such as the Sally-Anne test (Baron-Cohen et al., 1985) and the dichotomous outcome (pass-fail) on this test was used as a measure of acquisition of the theory of mind.

**MATERIAL AND METHODS**

**Participants**

The sample for this study 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, they were all free of any known neurological and/or psychiatric conditions or developmental disability.

**Procedure**

Out of 30 public kindergartens in Canton Sarajevo, we selected 8 small-sized public kindergartens (up to 50 children) and provided preschool teachers with
the consent forms for the children’s parents. 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 a voluntary basis and that the obtained data would be analyzed anonymously. This study was part of a larger study examining the executive function of preschool children in Canton Sarajevo. After the consent forms were returned (out of 200 consent forms, 158 were signed and returned, a 79% response rate), we tested the children using 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 a convenient space 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). This left us with a final sample of 116 children from these 8 kindergartens for whom we had the complete data. Some findings from this project regarding the effects of age and gender on finger tapping speed and semantic fluency have been published earlier (Memisevic et al., 2017a; Memisevic, Ibralic, & Pasalic, 2017b). 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.

**Measures**

The 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 our study we used dolls named “Emina” and “Maja,” who were playing with a ball and two boxes (red and blue). The experimenter 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 would Emina look for the ball, under which box. The outcome of this test was “pass” or “fail,” and this result was used as a dependant measure in the logistic regression. The correct answer was recorded only if the child was able to explain why Emina would look for the ball under the red box. The original task did not ask the children to justify their response. We asked for justification because we wanted to make sure that the children had acquired TOM while without explanation 50% of the children might have guessed the correct answer by chance alone.

The simple reaction time test is a computerized test in which children are required to press the space button on a computer any time they see a star appearing on the screen. The program used for this assessment was *Attenzione e concentrazione* (Di Nuovo, 2000). There are 4 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 used only the
number of correct answers as the outcome measure (possible range between 0 and 30). Although the simple reaction time test on the surface seems like a superficial test, it involves many mental processes and their underlying structures; for being able to respond fast requires continuous correction via excitatory and inhibitory motor mechanisms (Niemmi & Naatanen, 1981).

The multiple choice reaction time test is a computerized test similar to the simple reaction time test, only this time the subjects have distracters (other objects) appearing randomly on the screen. This test is also from the computer program *Attenzione e concentrzone* (Di Nuovo, 2000). Subjects need to respond only to the target stimuli (a star) appearing on the screen while suppressing the response to other, non-target stimuli. This test has the same outcome measures as the Simple Reaction time test and as the predictor we used only the number of correct answers (ranging from 0-9).

Semantic Fluency tasks. In this task we asked children to name as many words in 60s belonging to a certain category. The semantic categories we used were: animals, food and musical instruments. The number of retrieved words in each category was used as a predictor of the theory of mind.

### Statistical analysis

The dependant variable was the Sally-Anne test, which had a dichotomous outcome (pass/fail). The independent variables were age, gender, the number of correct answers on the simple reaction test, the number of correct answers on the multiple choice reaction test, and the results from the three semantic fluency tests. A logistic regression was used to assess the strength of explanatory variables. Data were analyzed with the computer program SPSS for Windows (v.13). For all tests, an alpha level of statistical significance was set at p<.05.

### RESULTS

A logistic regression was used to predict the probability that the child has acquired the theory of mind as demonstrated by the Sally-Anne test. The predictor variables were the child’s age, gender, the simple reaction time test, the multiple choice reaction test, and the three semantic fluency tests. Prior to conducting logistic regression, we tested predictors for eventual collinearity and there was no collinearity between the predictors according to the tolerance value and variance inflation factor (VIF) (all VIF<2). As we had no previous hypothesis on this model, we used a forced entry method instead of stepwise methods (Field, 2005).

Out of 116 children, 34 of them (29.3%) passed the Sally-Anne test and the rest of them failed. The model predicting the success on the Sally-Anne test was statistically significant $\chi^2(7, N=116) = 36.4, p<.001$. This model correctly classified 58.8% of the children who passed the test and 89.0% of the children who failed the test. The overall success rate of the model was 80.2%.

In Table 1 are the results of the logistic regression with all the predictors.
As can be seen from the table, the predictors of age, the multiple reaction time test and the semantic category – musical instruments were statistically significant (p<.05). The overall model was highly significant and accounted for about 30-40% of the variance in the results. In order to put these results more into perspective, and having in mind the results from the classification summary (the percentage of correctly identified cases who passed or failed the test), this basically means that low results on the semantic fluency test - musical instruments category, younger age and the low number of correct answers on the multiple reaction time test almost certainly mean that the child does not have a developed theory of mind. On the other hand, higher results on these tests and the older age of the child are associated with the child having acquired a theory of mind.

All of the other predictors were not statistically significant and were not related to the acquisition of the theory of mind.

### DISCUSSION

The goal of the present study was to assess the effects of age, gender, inhibitory control, and verbal fluency on the development of the theory of mind in preschool children. The significant predictors were age, semantic fluency – the category of musical instruments and the number of correct answers in the multiple reaction time test. The rest of the predictors were not statistically significant. The first predictor that was statistically significant in this model was the age of the child. There are a plethora of studies that demonstrated the significant effect of age on the development of the theory of mind in preschool children. Some studies indicate that it is not expected for children younger than 4 years of age to acquire the theory of mind, more specifically to understand that people with a mistaken belief will take the wrong action in the implementation of their goal (Perner & Lang, 1999). The majority of typically developing children have acquired an understanding of mind by 4 years of age (Cutting & Dunn, 1999). When compared to younger children, 4-year-olds have a better ability to understand their own and others’ beliefs (Brandt, Buttelmann, Lieven, & Tomasello, 2016).

However, in this study, although statistically significant, the age was not the strongest predictor of the theory of mind. This might be due to the small sample size, as there were only 34 children who passed the test (29.3%). There might
be a number of possible explanations for this finding. For example, we did not control for some other demographic variables that could have an impact on the theory of mind such as intelligence, socio-economic status, kindergarten experience etc. We also did not control for the impact of family size, especially the number of siblings as this factor is known to have an impact on theory of mind acquisition. In a study by Perner et al. (1994) the authors found that children from larger families were better able to successfully solve false-belief tasks. The next important predictor for the theory of mind in our study was semantic fluency - the category of musical instruments. It is a well-established fact that language development in early years plays a very important part in the acquisition of the theory of mind (Brooks & Meltzoff, 2015). In this study we used three semantic fluency categories as predictors of the theory of mind: animals, food and musical instruments. However, only the category of musical instruments was predictive of the theory of mind. Of all these three semantic categories, the lowest mean score was for the category of musical instruments, so it was the hardest task for children to retrieve the words in this category. A possible explanation for this finding is that more difficult forms of semantic fluency categories are probably more correlated with intelligence, which might have had a confounding effect on the theory of mind. Another, and equally likely, explanation might be the confounding effects of family environment. Children who live in cognitively stimulant environments tend to have a richer vocabulary and a better theory of mind (Cutting & Dunn, 1999). Many studies have established a strong relationship between language skills and the theory of mind. For example, Ziatabar Ahmadi et al. (2014) have concluded that language skills are the most important predictor of the theory of mind (Ziatabar Ahmadi, Nakhostin Ansari, & Ashayeri, 2014). Training on language tasks such as sentential complements has a strong positive effect on a number of theory of mind tasks (Hale & Tager-Flusberg, 2003).

The strongest predictor for the theory of mind in this study was the inhibitory control but only the more complex form of the test - the multiple choice reaction time. As this test involves strong demands on executive control, more specifically on behavioral inhibition, we confirmed a strong association between the theory of mind and executive control. These results support the claim that executive functions, at least some of its components are good predictors of a theory of mind. Earlier studies have also found a relationship between inhibitory control and tasks tapping the theory of mind (Hughes, 1998). It would be very useful to assess which executive functions are the strongest predictors of the theory of mind. Similar studies of executive functions predicting other outcome variables such as visual-motor integration have already been conducted (Memisevic & Sinanovic, 2013).

Contrary to our expectations, the age effects for the theory of mind were not very large in this study. It is likely that some environmental effects, such as family environment, might have contributed to this result, as they were not controlled for. Family environment has proven to be of extreme importance for developing the theory of mind (Cutting & Dunn, 1999). Stronger predictors for a theory of
mind were semantic fluency for complex categories and inhibitory control. This information is very useful as it might help us in creating programs for developing a theory of mind at preschool institutions. Given the importance of the theory of mind for the social development of children, professionals creating preschool curriculums should pay more attention to this segment of a child’s development. There is strong evidence that the theory of mind can be successfully trained and improved, even in the short time-frame of just two weeks (Slaughter & Gopnik, 1996). These programs aimed at improving the theory of mind can be particularly useful for children with known developmental disabilities, such as for children with autism spectrum disorder (Ozonoff & Miller, 1995). Training activities in the area of the theory of mind have also led to improvements in children with hearing impairments (Wellman & Peterson, 2013). It is evident that these programs can be useful for all children, regardless of the presence of disability and the disability type.

It is important to mention several limitations of this study. First of all we used only one outcome variable for theory of mind assessment and that was the Sally Anne task. It would be more informative to use a couple of tasks tapping the theory of mind and perhaps to use parent/caregiver reports on theory of mind development. Another limitation of this study deals with the predictors we used. There are many other predictors that could have been used in this regression such as family environment, the number of siblings etc.. Future studies should take into considerations these predictors as well and aim to create an even better model for predicting the theory of mind or introduce to the clinical practice the other model of brain functioning in children based for example on microgenetic theory (see: Pachalska et al 2017).

REFERENCES


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