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THE EFFECTS OF AGE AND GENDER ON FINGER TAPPING SPEED IN PRESCHOOL CHILDREN

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SUMMARY

Background: The assessment of children's motor control is very important in detecting potential motor deficits. The Finger Tapping Test (FTT) is a widely used test in various clinical and non-clinical populations. FTT is a neuropsychological test designed to measure motor control. Age and gender are significant predictors of finger tapping speed in school-aged children. The goal of the present study was to determine the effects of age and gender on finger tapping speed in preschool children.

Material/ Methods: The sample for this study included 111 preschool children, aged 3 to 6 years (mean age- 4.6; SD- 0.9), of both genders (59 boys, 52 girls). As a measure of finger tapping speed we used the Finger Tapping Test from the Psychology Experiment Building Language (PEBL).

Results: The results of this study found a significant effect of age on finger tapping speed. Contrary to the existing studies, there was no gender effect on the tapping speed in preschoolers. A one way analysis of variance showed that older children performed significantly better than younger children.

Conclusions: There is a linear trend of improved performance on FTT with an increasing age. The child's gender was not a significant predictor of FTT for preschool children. Motor control and speed can be improved through exercise.

Key words: finger tapping, gender effect, age effect, preschool children

BACKGROUND

The assessment of children's motor functions is very important as it can reveal certain motor deficits (Gidley Larson et al., 2007). One way to determine such deficits is through the use of motor performance tests such as the Finger Tapping Test (FTT). This test belongs to a group of neuropsychological tests measuring motor functioning, specifically motor speed and hand coordination (Ward et al., 2013). The low performance on this test can indicate some clinical conditions such as brain injury, neurodegenerative diseases, neurodevelopmental disorders etc.. For example, children with conditions such as Attention Deficit Hyperactivity often fail to meet age-appropriate norms for motor control and timed repetitive movements (Gilbert, Isaacs, Augusta, Macneil, & Mostofsky, 2011). Indeed, the FTT has been widely used in clinical populations such as with people with depression (Moniz, De Jesus, Pacheco, Gonçalves, & Viseu, 2016), people with schizophrenia (Carroll, O'Donnell, Shekhar, & Hetrick, 2009), people with Parkinson disease (Jobbágy, Harcos, Karoly, & Fazekas, 2005; Shimoyama, Ninchoji, & Uemura, 1990), Korsakoff's syndrome (Welch, Cunningham, Eckardt, & Martin, 1997) etc. The FTT was also used as a measure of neurorehabilitation outcomes after unilateral cerebral vascular incidents (Prigatano et al., 1997). Besides clinical populations, the FTT was also used in large community-based samples of adults (Hubel, Reed, Yund, Herron, & Woods, 2013). However, much less information is available regarding the finger tapping speed in children, especially in preschool children. There are some studies that examined the neuroanatomical correlates of finger tapping in children with Fetal Alcohol Syndrome (du Plessis et al., 2015) and in children with cerebral palsy (Hervey et al., 2014). The brain areas activated during the FTT included both superior temporal gyri, both sensorimotor cortices, anterodorsomedial cerebellum and supplementing motor area (Desmond, Gabrieli, Wagner, Ginier, & Glover, 1997; Rivkin et al., 2003). Existing studies examining the school-age children's tapping speed performance have shown that gender and age play an important role in tapping speed (Carlier, Dumont, Beau, & Michel, 1993). Besides these predictors, studies have shown that children's socioeconomic status and intellectual functioning also have a strong impact on finger tapping speed (Prigatano, Gray, & Legacy, 2008). Although there are many studies examining fine and gross motor skills in preschoolers (Goyen, Lui, & Woods, 1998; Memisevic & Hadzic, 2013a; Westendorp, Hartman, Houwen, Smith, & Visscher, 2011) there are none, to the best of the authors' knowledge, that have dealt specifically with the predictors of finger tapping speed in this population. As the current studies of school-age children has examined and discovered the influence of age and gender on the finger tapping speed, we wanted to check whether these variables also play a role in predicting the speed of tapping in preschoolers and if so, to what extent. Thus, the goal of the current study was to examine the influence of age and gender in predicting the finger tapping speed of the preschoolers.

METHOD

Participants

The sample for this study comprised 111 preschool children aged 3 to 6 years (mean age= 4.6 years, SD= 0.9 years). There were 52 girls (46.8%) and 59 boys (53.2%) in the sample. There were no statistically significant differences in the mean age between boys and girls ($t=0.05$; $p=.97$). Children were attending public preschool institutions in Canton Sarajevo, Bosnia and Herzegovina. 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 4 small-sized public kindergartens (between 30-50 children) and provided the preschool teachers with the consent forms for 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 160 consent forms, 130 were signed and returned: an 81% response rate), we tested the children on the Finger Tapping Test from the Psychology Experiment Building Language. The children were tested by trained data collectors with advanced degrees in psychology, speech and language therapy and a specialist education. All the children were tested individually, in the morning hours, in a convenient space at the kindergartens. Completing the testing session lasted approximately 15 to 20 minutes for each child, with the FTT not lasting longer than 3 minutes. Some children were sick at the time of testing (n=12) or did not want to do the tests (n=7). This left us with the final sample of 111 children from these 4 kindergartens. The approval for this study was obtained from the Canton Sarajevo Ministry of Education and the Ethical Committee Board of the Faculty of Educational Sciences at the University of Sarajevo. Only children with written parental consent were tested.

Instrument

The Finger Tapping Test from the Psychology Experiment Building Language (PEBL) was used as a measure of tapping speed (Mueller, 2013). It is a free software that allows researchers to design and run numerous performance tests (Mueller & Piper, 2014). The concurrent validity of the PEBL Finger Tapping Test has been demonstrated in previous studies (Moniz et al., 2016). Children choose for themselves which hand to use for the tapping. All children chose to do the task with the right hand. We measured taps from three consecutive trials (each lasting 10 seconds), with a brief rest between trials of 30 seconds. The dependent variable was the mean number of taps from the three trials. Children were told to tap with the index finger of only one hand (without alternating hands). Children were free to choose in what way they were to tap, as we did not place any restrictions on hand position. All children understood the task and performed it accordingly.

Statistical analysis

The predictors of finger tapping speed were the age and gender of the children. The dependent variable was the mean number of taps from three consecutive trials. A Multiple Regression Analysis was used to determine the strength of the predictors. In order to obtain a more detailed insight into the data, the variable age was split into three categories and one way Analysis of Variance (ANOVA) was conducted on the mean finger tapping scores in relation to the age category of the children. ANOVA was followed by the Hochberg post hoc test. Lastly we performed a comparison of the mean scores of finger tapping scores in relation to a child's gender as these data may be useful for subsequent meta-analysis. Data were analyzed with the SPSS for Windows (v.13) computer program. For all the tests, an alpha level of statistical significance was set at $p<.05$.

RESULTS

We first performed a multiple regression analysis to evaluate the effects of gender and age (both predictors in one block, enter method) on the Finger Tapping Test. There were no missing data on this test. The results are shown in Table 1.

As expected, the age of the child was a significant predictor of the tapping speed. However, the effect of gender was somewhat surprising, given that it did not have a significant impact on tapping speed. The correlation between age and tapping speed was highly significant ($r=.53$; $p<.001$). Put another way, an increase in a child's age (approximately 1 year) will result in the child's result on tapping speed being higher by 4 or 5 points (4.4 exactly). As can be seen from the table, the total amount of explained variance for the scores on the Finger Tapping Test is 28%, given these predictors (age and gender).

To give a more detailed insight into the age trends, we split the age variable into three age groups: 1. The first group consisted of children between 3 and 4 years of age, 2. The second group of children between 4.1 and 5 years of age and 3. The third group of children between 5.1 and 6 years of age and performed by a one-way Analysis of Variance (ANOVA), which was followed by a Hochberg

Table 1. Regression analysis summary for age and gender predicting children's tapping speed

Variable	B	SEB	β
Gender	-.66	1.2	-.04
Age	4.4	.68	.53*

Note. $R^2=.28$ ($N=111$; $p<.001$); *$p<.001$.

Table 2. The mean scores on Finger Tapping Test for different age groups

Age group	Mean	SD	N
3-4 years	27.2	6.8	34
4.1-5 years	31.7	7.3	34
5.1-6 years	35.9	6.3	43

Table 3. Mean Finger Tapping Scores for boys and girls

	Finger tapping score		t (109)
	M	SD	
Boys	31.7	8.2	.43*
Girls	32.3	6.9	

Note. N=111; *p=.67.

test, as the sample sizes were not equal across groups. There was no violation of the homogeneity of variance as the Levene test was not significant (p=.64).

The results of ANOVA revealed statistically significant differences between the age groups (F(2)=15.5; p<.001). A post hoc Hochberg test indicated significant differences between all the age groups: 1. The 3-4 year group vs. the 4.1-5 year group (mean difference -4.5; p=.023), 2. The 3-4 year group vs. the 5.1-6 year group (mean difference -8.7; p<.001) and 3. The 4.1-5 year group vs. that of 5.1-6 year-olds (mean difference -4.2, p<.024).

The mean and standard deviations for the age groups is shown in Table 2.

The data in Table 2. clearly indicate a linear trend of finger tapping improvement with increasing age.

Further we present the mean scores of boys and girls on the Finger Tapping Scores. We have also provided data regarding the t-test between the means of the two groups as it might be useful to researchers conducting meta-analysis.

The mean score on the Finger Tapping Test was 32.0 and the standard deviation was 7.6. The descriptive data for the scores on the Finger Tapping Test in relation to the child's gender are presented in Table 3.

DISCUSSION

The goal of the present study was to determine the effects of gender and age on finger tapping speed. As predicted, the children's age was a significant predictor of finger tapping speed and this finding is in line with existing studies on school aged children (Prigatano et al., 2008). Older children were faster than younger children on this test. It is probable that the correlation between age and finger tapping speed has an "inverse U" shape with the peak in performance in the early 20s, and then gradually decreasing (Cousins, Corrow, Finn, & Salamone, 1998; Lezak, Howieson, & Loring, 2004). As has been already mentioned, there are few studies that examined the finger tapping performance in preschool aged children. The existing studies included children aged 5 and older but did not include children younger than 5 years. Children as old as 4 years of age should be able to do the Finger Tapping Test (Telzrow & Hartlage, 1983). We also included a group of children aged 3 and older and measured their performance. That is one possible limitation of this study regarding the validity of the data obtained for this group of children. Given that the age trend was strong and consistent, this concern is somewhat reduced. Regarding the performance of the children it is important to provide a brief qualitative description. Children between the ages of 3-4 years were less focused, less precise and less motivated to do the task than the older children. However, we believe that the performance reflects their true level of motor performance. Some of them were verbally encouraged to finish the test.

In relation to the effect of gender on finger tapping speed, this study found somewhat unexpected results. This study failed to detect any gender effect on finger tapping speed in preschool children. Studies regarding the effect of gender on finger tapping are ambiguous, although there seems to be more studies supporting the idea that males are faster. For example, in the previously mentioned study by Pritagano et al. (2008), the authors found statistically significant differences in favor of males and the effect size was moderate (Cohen's d=0.51). Males outperformed females in finger tapping in a study regarding manual symmetry (Schmidt, Oliveira, Krahe, & Filgueiras, 2000) and in a study regarding gender and age-specific changes in motor speed (Ruff & Parker, 1993). There are far fewer studies where no gender effect was found. One such study involved male and female pianists and the authors did not find any significant effect of gender on finger tapping speed (Aoki, Furuya, & Kinoshita, 2005). One possible explanation of this finding is that the training has an impact on equalizing the differences between males and females. Regarding the preschool children, performance in relation to gender probably depends on the type of task. For example, research on the visual-motor integration of preschool children has shown that girls almost constantly perform better than boys (Böhm, Lundequist, & Smedler, 2010; Memisevic & Hadzic, 2013b). One possible explanation for the female advantage on visual-motor integration tasks is the earlier maturation of the cortical functions that control the serial organization of simple motor repetitions in girls (Wolff & Hurwitz, 1976). However, it seems that different cortical mechanisms are involved in finger tapping task, thus providing evidence for the multidimensional nature of fine motor skills and the complex cortical organization of these skills. Fine motor skills are very important for everyday functioning and they are a significant predictor of a child's later academic achievement (Grissmer, Grimm, Aiyer, Murrah & Steele, 2010). Many activities can have a positive impact on motor skills (Pachalska, Goral-Polrola, Brown & MacQueen, 2015; Ishikura, 2016). For example, finger tapping training can have a positive effect on motor control (Koeneke, Lutz, Esslen, & Jancke, 2006) which can be very useful for children having difficulties in writing. Fine motor training not only improves concrete motor skills but also induces structural neural changes (Draganski et al., 2004). This in turn can have a tremendously positive effect on children's social and academic outcomes. Curriculum creators in the field of early childhood education should be aware of this and should incorporate fine motor training/ games as an important part of the curriculum.

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