Sportif Bakış: Spor ve Eğitim Bilimleri Dergisi, 7(2): 159-166, 2020 Araştırma Makalesi
www.sportifbakis.com
E-ISSN: 2148-905X
doi: 10.33468/sbsebd.143

The Effect of Open and Closed-Skill Sports on Cognitive Functions

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Abstract

This study aimed to compare amateur athletes' cognitive function performances in table tennis, an open-skill sport requiring close attention and cognitive function, and athletes, a closed-skill sport where environmental stimuli do not change. This study included 28 table tennis players (mean age: 19.82 3.90 years, mean height: 175.10 7.04 cm), 23 athletes (mean age: 20.60 .03 years, mean height: 171.30 8.37 cm), 22 Sedentary (mean age: 18.86 4.16 years, mean height: 174.91 7.62 cm), a total of 73 volunteers participated. Trail Making Tests (A and B) were applied to determine the participants' cognitive function levels. Part A measures cognitive characteristics such as motor processing speed, number sequencing (A time), and part B measures cognitive characteristics such as attention, set changing ability, cognitive flexibility (B time). The application was conducted in a quiet, noiseless environment with only the researcher and the participant. The completion times of the test were recorded in seconds. "SPSS22.0" statistical package program was used in the analysis of the data. In examining the statistical difference between independent groups in categorical data analysis, the Kruskal Wallis test was used. Tamhane post hoc test was applied to determine the difference between groups. Significance level <.05 was selected. In the Kruskal Wallis test comparisons, no significant difference was found between the groups in terms of Trail Making Test A times (p> 0.05). In contrast, a statistically significant difference was found between the groups in terms of the trail, making test B times (p <0.05). In the post hoc comparisons, a statistically significant difference was found between the table tennis-athletes and table tennis-control groups in the B part of the trail making test (p <0.05). However, there was no significant difference between athletes and control groups (p> 0.05). In line with the findings obtained from the study, it was determined that the executive function performances of young individuals who do open-skill exercises were better than the closed-skill and control groups.

Key Words: Open skill, closed skill, cognitive function, mental performance

1. INTRODUCTION

Open-skill refers to the skills that require high-level, complex cognitive processes such as attention, perception, planning, set changes, and interpretation, which include unpredictable external factors. Closed-skill is a type of skill with predictable environmental factors (Galligan, 2000; Gu et al., 2019). Accordingly, depending on the type of skill, sports branches also differ in cognitive functions. During exercise, training, or competition, it is necessary to give the most appropriate reaction to many different stimuli and act as soon as possible. In this process, the ability of individuals to use cognitive processing processes (attention, focus, decision making) in suddenly changing situations determines the physical performance of the person (Jacobson and Matthaeus, 2014; Dai et al., 2013; Alesi et al., 2016; Vestberg et al., 2017).

Cognitive function is defined as mental information acquisition through perception, attention, visual, spatial processing, language, memory, executive functions, thoughts, experiences, and senses (Gu, et al., 2019). Cognitive function changes depending on alcohol and smoking (Ferreira et al., 2019), age (Harada et al., 2013), exercise and exercise type (Dai et al., 2013), an education level (Reas et al., 2017) and nutrition (Richard et al., 2018). In addition to these has been shown that it is affected by the type of skill (open-closed) required by the sports branch (Jacobson and Matthaeus, 2014; Dai et al., 2013). When the literature is examined, open-skill sports branches with complex cognitive processes such as strategy development and interpreting the prior information obtained from the opponent require higher cognitive skills than closed-skill sports branches (Wang et al., 2013; Bianco et al., 2017).

In recent years, the effect of open and closed-skills on cognitive functions has attracted scientific researchers' attention. According to the findings obtained from the study, while the effects of open skill sports on cognitive functions were determined in the elderly (Dai et al., 2013), disabled (Di Russo et al., 2010), children (Alesi et al., 2016) groups. However, an insufficient number of studies cause conflicting information about young people. It has been suggested that open-skill sports do not contribute to cognitive functions, since youth is a maturation period and peak cognitive processes (Gu et al., 2019). Due to this uncertainty, studies examining the effects on young people are needed.

In line with this information, this study aimed to compare amateur athletes' cognitive function performance in table tennis (TT), which is an open-skill sport that requires close attention and cognitive function, and athletes, which is a closed-skill sport where environmental stimuli do not change.

2. METHOD

Before any assessment was done, all participants were informed about the study and, an informed consent form was obtained. Testing was carried out in a closed area where only the researcher and the participant were present not to distract. When the participant was ready, he was asked to do parts A and B, respectively, and test completion times were recorded.

2.1. Trial Making Test (TMT)

TMT is a complex visual scanning test that contains engine components. It is sensitive to functions in the frontal region of the brain. High-level cognitive function skills such as speed, motor skill, attention, perception, planning, and set changes are required to achieve good scores in this test. The test consists of two separate parts, A and B part. Participants are required to connect the circles (1-2-3…) with numbers in section A by drawing lines consecutively and correctly. In section B, they need to connect the circles (1-A-2-B-3…) with numbers and letters by drawing lines consecutively and correctly as one digit and one letter (Armigate, 1946). It is understood that the B part of the test is more complicated than part A, from the slowdown in the reaction time seen in part B (Cangöz, 2009). Part A measures cognitive characteristics such as motor processing speed, number sequencing (A time), and part B measures cognitive characteristics such as changesets and cognitive flexibility (B time). In Form A, participants are asked to combine the scattered numbers on a white form with a pencil from 1, while in

E-ISSN: 2148-905X
doi: 10.33468/sbsebd.143

B form, they are asked to combine letters and numbers in scattered order, 1-A, 2-B, 3-C (Reynolds, 2002; Cangöz, 2009; Türkeş et al., 2015; Gomez et al., 2001; Sezgin et al., 2017).

TMT is used in both Turkish and English letters. In the study conducted on individuals under 40 years of age, it was shown that there was no difference between the use of the English alphabet and the Turkish alphabet. Therefore, the original form, the English alphabet, was used in this study (Cangöz, 2009). Anıl et al. (2003) conducted a Turkish validity and reliability study of the test.

2.2. Height, Weight and BMI

Participants' height was measured with a digital scale with a precision of 0.1 kg, and body weights with a height gauge with a precision of 0.1 cm. Body mass index was calculated by dividing the kg value of weight by the square of the height in cm (Philip et al., 2001).

2.3. Subject

Our study included 28 TT players (mean age: 19.82 3.90 years, mean height: 175.10 7.04 cm), 23 athletes (mean age: 20.60 .03 years, mean height: 171.30 8.37 cm), 22 sedentary (mean age: 19.82 3.90 years) mean age: 18.86 4.16 years, mean height: 174.91 7.62 cm) with a total of 73 volunteers.

2.4. Data Analysis

"SPSS 22.0" statistical package program was used to analyze the data. In analyzing the statistical difference between independent groups in categorical data analysis, the Kruskal Wallis test was used. Tamhane post hoc test was applied to determine the difference between groups. Significance level <.05 was selected.

3. FINDINGS

Table 1. Kruskal wallis test results for TMT time by groups

Test	Group	N	Mean Rank	X^2	df	p
Time A	TT	28	31,75	6,49	2	,059
	Athletes	23	34,33			
	CG	22	46,48			
Time B	TT	28	16,70	43,16	2	**,000**
	Athletes	23	45,80			
	CG	22	53,64			

p>0.05

When Table 1 is examined, it was determined that the mean rank in the completion times of the TMT-A section was 31.75 in the TT group, 34.33 in the athletes group, and 46.48 in the control group (CG), respectively. In the TMT-B part's completion times, the mean rank was 16.70 in the TT group, 45.80 in the athletes group, and 53.64 in the CG. In the comparisons, there is no significant difference between the groups in the TMT-A and B sections (p> 0.05),

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E-ISSN: 2148-905X
doi: 10.33468/sbsebd.143

Table 2. Post hoc (tamhane) comparisons

Test	Group	N	Mean	±	Comparison	p
	TT	28	19,88	3,80	TT- Athlete	,971
Time A	Athlete	23	25,10	5,50	TT-CG	,080
	CG	22	30,71	9,38	Athlete -CG	,131
	TT	28	43,42	1,84	TT- Athlete	**,000**
Time B	Athlete	23	54,06	4,22	TT-CG	**,000**
	CG	22	65,56	3,20	Athlete -CG	,274

$p>0.05$

In the post hoc comparisons, there was no significant difference between groups in the TMT-A section ($p> 0.05$). In contrast, a statistically significant difference was found between TT and both athletes and CG in the TMT-B section ($p <0.05$). No significant difference was found between athletes and CG in the TMT-B section ($p> 0.05$).

4. DISCUSSION

The present paper aimed to analyze young adults' executive function performances who do open-skill (TT) and closed-skill (athletes) sports. Findings related to the study were discussed and presented below by supporting them with the findings in the literature. Elferink et al. (2018) examined the status of 30 elite (16 ± four years old) and 30 sub-elite (16 ± five years old) athletes in terms of short-term memory and cognitive flexibility. They traced that both groups performed above the norm values. They stated that their executive functions were better than normal in both groups as they practiced open-skill sports. In the study conducted by Jacobson and Matthaeus (2014) (n = 54), it was shown that decision making and attention skills of those who do open-skill sports are higher. Pačesová et al. (2018) found that open-skill athletes were better at skills such as information processing speed, attention, and selected attention than the sedentary group. KoutsandrÉou et al. (2016) examined the effect of different exercises on children's working memory; It was determined that the group doing motor skills requiring open-skills had better working memory performance than the group doing cardiovascular exercises. Jacobson and Matthaeus (2014) found that those who do sports have better executive functions than those who do not. They also observed differences according to sports types. They showed that closed-skill athletes achieved higher scores in blocking tasks and open-skill athletes in problem-solving skill.

The methodological difference draws attention to the studies. The cognitive processes of doing exercises involving open-skills are positive, despite the differences in the average age of the subject groups (children, young, old), physical status (elite, amateur, disabled), sports branches (tennis, basketball, swimming, athletes) and measurement method (objective, subjective). It seems that there is a consensus that it will affect. Di Russo et al. (2010) investigated the effect of open-skill training on cognitive functions in a study conducted with 35 participants. In the study, 17 disabled athletes (9-wheeled basketball athletes), eight swimmers, and 18 healthy non-athletes participated. When they compared basketball players with swimmers, they found that basketball players showed less variability in reaction times in behavioral tasks that included visual stimulus recognition, stimulus-response mapping, and motor response/inhibition. As a result, they reported that

E-ISSN: 2148-905X
doi: 10.33468/sbsebd.143

participating in an open-skill sport such as basketball can improve certain executive functions.

In another study, Dai et al., (2013) examined the effect of no exercise on executive cognitive functions and mental performance with a group whose mean age of the subject groups was high. A total of 32 people between the ages of 65-75 participated in their work. While 16 of the participants do open-skill sports (mostly TT and tennis), 16 do closed-skill sports (mostly swimming and running). In the comparisons made, it was found that both groups were exercising improved in executive functions. However, it was specially stated that doing open-skill sports will increase this even more. Tsai et al. (2017) A total of 64 children between the ages of 60-80 that make up the closed-skill (cycling, walking, low pace running, n = 22), open-skill (TT, n = 21), and CG (n = 21). examined the neurocognitive effects of 6 months of exercise with the participant. At the end of the study, they found that both the open and closed-skill groups had higher cognitive skills than the CG. As a result, they reported that it would be beneficial to exercise life-long to reduce cognitive losses caused by aging to improve cognitive skills (Birinci et al., 2019). It has been reported that closed-skills also improve cognitive functions in the elderly, but open-skills improve more (Gu et al., 2019).

A study on children also examined whether regular physical activity positively affects children's executive function (Alesi et al., 2016). For this purpose, they tested the effects of the football exercise program (6 months), which includes open-skills such as coordinative skills and executive functions (updating, attention, blocking, and planning processes). The study was conducted with 44 participants (24 training group mean age 8.8 years, 24 sedentary mean age 9.2 years). According to the study's data, the agility, visual-spatial working memory of the football training group, They found a significant difference in attention, planning, and inhibition skills compared to the sedentary group. It stated that exercising expressive skills was a natural way to improve cognitive skills.

5. CONCLUSION

As a conclusion, there was no significant difference between groups (TT, CG, Athlete) in the TMT-A section ($p > 0.05$). In contrast, a statistically significant difference was found between TT and both athletes and CG in the TMT-B section ($p < 0.05$). No significant difference was found between athletes and CG in the TMT-B section ($p > 0.05$). Although the subject groups in the literature, measurement method or the sports branches examined differ, it is widely found that exercises with open-skills improve cognitive flexibility, attention, perception, inhibition, and short-term memory. According to the literature, it is thought that disabled and sedentary individuals need to do exercises with open-skills to improve or protect cognitive functions. Primarily, it is recommended that children and older adults should do exercises that include open-skills throughout life. In this study, similarly, the executive function performances of young individuals who do open-skill exercises are better than the closed-skill and control groups.

Conflict of Interest

The author declares no conflict of interest in the publication of this article.

E-ISSN: 2148-905X
doi: 10.33468/sbsebd.143

REFERENCES

Alesi, M., Bianco, A., Luppina, G., Palma, A., & Pepi, A. (2016). Improving children's coordinative skills and executive functions: The effects of a football exercise program. *Perceptual and motor skills*, 122(1), 27-46.

Anil, A. E., Kivircik, B. B., Batur, S., Kabakçi, E., Kitis, A., Güven, E., ... & Arkar, H. (2003). The Turkish version of the Auditory Consonant Trigram Test as a measure of working memory: A normative study. *The Clinical Neuropsychologist*, 17(2), 159-169.

Armigate, S. (1946). Analaysis of certain psychological tests used for evaluation of brain damage. *Journal of Gerontology*, 60, 30-34.

Bianco, V., Di Russo, F., Perri, R. L., & Berchicci, M. (2017). Different proactive and reactive action control in fencers' and boxers' brain. *Neuroscience*, 343, 260-268.

Birinci, Y. Z., Şahin, Ş., Vatansever, Ş., & Pancar, S. (2019). Yaşlılarda fiziksel egzersizin beyin kaynaklı nörotrofik faktör (bdnf) üzerine etkisi: Deneysel çalışmaların sistematik derlemesi. *Spor Hekimliği Dergisi*, 54(4), 276-287.

Cangöz, B. (2009). Türkçe ve İngilizce alfabe kullanımı genç ve yaşlı yetişkinlerin iz sürme testi (İST) puanlarını etkiler mi?. *Journal of Faculty of Letters/Edebiyat Fakultesi Dergisi*, 26(2).

Dai, C. T., Chang, Y. K., Huang, C. J., & Hung, T. M. (2013). Exercise mode and executive function in older adults: An ERP study of task-switching. *Brain and cognition*, 83(2), 153-162.

Di Russo, F., Bultrini, A., Brunelli, S., Delussu, A. S., Polidori, L., Taddei, F., ... & Spinelli, D. (2010). Benefits of sports participation for executive function in disabled athletes. *Journal of Neurotrauma*, 27(12), 2309-2319.

Elferink-Gemser, M. T., Faber, I. R., Visscher, C., Hung, T. M., De Vries, S. J., & Nijhuis-Van der Sanden, M. W. (2018). Higher-level cognitive functions in Dutch elite and sub-elite table tennis players. *PloS one*, 13(11), e0206151.

Ferreira, V. R., Jardim, T. V., Sousa, A. L. L., Rosa, B. M. C., & Jardim, P. C. V. (2019). Smoking, alcohol consumption and mental health: Data from the Brazilian study of cardiovascular risks in adolescents (ERICA). *Addictive behaviors reports*, 9, 100147.

Galligan, F. E. A. (ed.). (2000). *Acquiring skill in Advanced PE for Edexcel*. Bath: Bath Press, 102–108.

Gomez-Merino, D., Bequet, F., Berthelot, M., Riverain, S., Chennaoui, M., & Guezennec, C. Y. (2001). Evidence that the branched-chain amino acid L-valine prevents exercise-induced release of 5-HT in rat hippocampus. *International journal of sports medicine*, 22(05), 317-322.

Gu, Q., Zou, L., Loprinzi, P. D., Quan, M., & Huang, T. (2019). Effects of open versus closed skill exercise on cognitive function: A systematic review. *Frontiers in psychology*, 10, 1707.

E-ISSN: 2148-905X
doi: 10.33468/sbsebd.143

Harada, C. N., Love, M. C. N., & Triebel, K. L. (2013). Normal cognitive aging. *Clinics in geriatric medicine*, 29(4), 737-752.

Jacobson, J., & Matthaeus, L. (2014). Athletes and executive functioning: How athletic participation and sport type correlate with cognitive performance. *Psychology of Sport and Exercise*, 15(5), 521-527.

KoutsandrÉou, F., Wegner, M., Niemann, C., & Budde, H. (2016). Effects of motor versus cardiovascular exercise training on children's working memory. *Medicine & Science in Sports & Exercise*, 48(6), 1144-1152.

Pačesová, P., Šmela, P., Kraček, S., Kukurová, K., & Plevková, L. (2018). Cognitive function of young male tennis players and non-athletes. *Acta Gymnica,* 48(2), 56-61.

Philip T. J., Rachel, L., Eleni, K., & Maryam, S. (2001). The world wide obesity epidemic, *Obesity Research*, 9.

Reas, E. T., Laughlin, G. A., Bergstrom, J., Kritz-Silverstein, D., Barrett-Connor, E., & McEvoy, L. K. (2017). Effects of sex and education on cognitive change over a 27-year period in older adults: The Rancho Bernardo Study. *The American Journal of Geriatric Psychiatry*, 25(8), 889-899.

Reynolds, C. R. (2002). *Comprehensive trail making* test (CTMT). Austin, TX: Pro-Ed, 408.

Richard, E., Laughlin, G., Kritz-Silverstein, D., Reas, E., Barrett-Connor, E., & McEvoy, L. (2018). Dietary patterns and cognitive function among older community-dwelling adults. *Nutrients*, 10(8), 1088.

Sezgin, P., Budak, M. E., & Kara, D. (2017). Üniversite öğrencilerinin algıladığı stresiniz sürme testi performansına etkisi üzerine bir araştırma. *Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi*, 4(12), 645-656.

Tsai, C. L., Pan, C. Y., Chen, F. C., & Tseng, Y. T. (2017). Open-and closed-skill exercise interventions produce different neurocognitive effects on executive functions in the elderly: A 6-month randomized, controlled trial. *Frontiers in Aging Neuroscience*, 9, 294.

Türkeş, N., Can, H., Kurt, M., & Dikeç, P. B. E. (2015). İz Sürme Testi'nin 20-49 yaş aralığında Türkiye için norm belirleme çalışması. *Turk Psikiyatri Derg*, 26, 189-196.

Vestberg, T., Reinebo, G., Maurex, L., Ingvar, M., & Petrovic, P. (2017). Core executive functions are associated with success in young elite soccer players. *PLoS One*, 12(2), e0170845.

Wang, C. H., Chang, C. C., Liang, Y. M., Shih, C. M., Chiu, W. S., Tseng, P., ... & Juan, C. H. (2013). Open vs. closed skill sports and the modulation of inhibitory control. *PloS one*, *8*(2), e55773.

www.sportifbakis.com
E-ISSN: 2148-905X
doi: 10.33468/sbsebd.143

Makale Geliş : 03.09.2020
Makale Kabul : 20.10.2020