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FACULTY OF EDUCATION AND PSYCHOLOGY

Theses of the Doctoral Dissertation

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Sportágra jellemző döntéshozatali képességre alapozott prognosztizáló módszer kidolgozása sportági kiválasztás céljából

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Introduction

The level of physical activity of the emerging generation is declining recently, and their fitness state is getting spoiled. The benefit of the sport associations becoming even more important in the recent years than the physical education lessons in schools, where the kis getting the proper amount of load and the commitment for sports is facilitated by professionally skilled trainers. Many of the kids are quitting sports activities because the lack of successes. (Trzaskoma-Bicsérdy, 2007).

At the time of the choice of sports for the children, the main focus should be that fits their physical endowment and cognitive ability the best. This choice must be a responsibility and duty of the sports professionals. In the past, the PE teachers and coaches focused only on the physical endowment, when they recommended different sport arts for the children. (Csáki, et al, 2013). Cognitive abilities were pushed into the background. This resulted in such sports selections which did not fit for their cognitive abilities, so the lack of success and later the dropout became highly predictable. So the assessment of the children's cognitive abilities become more and more essential, to be able to select the proper sports for them (Derdák, 2018).

As Csáki et al. states: The other significant problem lies within the selection system of professional sports. Numerous study exaggerates that the talent and abilities should determine the final selection of proper sport arts for the children and not the body shape indicators, physical state. Fortunately, the recent years show a positive progress in the use of scientific based support systems, which provides a more holistic view in case of talent selection. During talent evaluation the experts examines the anthropometrical, psychological, sociological és technical aspects. (Unnithan, et al., 2012).

The relevance of the children's mental abilities are not negligible. Many studies show controversial results in examining the decisionmaking abilities of the youngsters within cognitive assessments. (Chmura, 1994; Nuri, et al., 2013; Makra & Balogh, 2018; McMorris & Graydon, 2000). Only a few studies can be found about the assessment of decisionmaking abilities of children during physical activities, in case of sport selection the number of experiments are even less and yet it should be taken into serious consideration that the physical strain is affecting the cognitive processes.

Studying the cognitive abilities as a result of psysical exercises are examined by the fields of psychology and psychophysiology. Studies - such as Rendi et. al. (2007.) Examining the relation between exerceise, load, and information processing - show strong connection between the physical activities and cognitive abilities. The functioning of the central nervous system activitated by physical exercise results in the improvement of the psychomotorical performance, recent study shows. After a certain level of intensity, the reaction time of choices are increasing. These observations are indicating a U-shape connection between the the activation level and performing different exercises, since the activation level elevates above the resting level, the performance level improves until the optimal level. From this point the activation level is growing constantly, which gradually redounds a poorer performance. The shortest response time can be seen in the aerobic range, while during the anaerobic phase the level of performance is degrading (Chmura, et al., 1994).

Other scientists also performed studies in this topic. In spite of previous studies McMorris and Graydon performed a highly thorough and systematic examination of the improving physical activites effecting the cognitive performance and they found little or no evidence for the inverted U hypothesis. Besides this they found evidence for the contrary, which indicates that the medium range physical activites are worsening the workmemory abilities and reaction time. (McMorris, et al., 2011). The following statement also strengthens the concept that the cognitive results are greatly dependent of the performed exercise (Rendi, et al., 2007). Other studies implicate that athletes show a higher sensory-cognitive ability according to their sports expertise, whether its an open or a closed sportsmanship. Volleyball players are tend to foresee the timing of the ball better than sprinters. Although, sprinters have a shorter reaction time in case of auditory stimuli during certain exercises (Nuri, et al., 2013). Smith et al. (2016) examined how the decisionmaking performance is developing after intensive exercises. They stated, that the cognitive performance declines to a large extent during an intensive training (performed at the maximum level of 90 bpm).

Polluveer et al. (2012) performed an experiment with the Win Psycho 2000 Programm (Thomson, 2010) in terms of decisionmaking abilities and reaction time of women volleyball players. The focus was mainly on the discrepancies between the position of the players and the their decisionmaking abilities. They came to the conclusion that significant differences can be found regarding the different positions on the court.

The Researches highlighted that, it is important to extend our perceptual – cognitive processing knowledge. One aspect of the information-processing ability is the decision making speed and accuracy (Thomson, et al., 2008). Thomson and his associates (2009) also tested ball players via the "Win Pyscho" 2000 program.

They examined the decision making ability before and after a heavy workload. The participants performances had deteriorated by the effects of heavy workload, however they have found significant differences between those previously mentioned features like reaction time, making mistakes, amongst athletes who are doing different kinds of ballgames.

From these studies we can draw a conclusion that, this decision making ability will have a really high importance of selecting athletes to a particular ballgame as an addition to the traditional measurements, such as the anthropometrical.

Examination of the Decision making ability amongst adult athletes. – 1. research

Aim and questions

Various workloads can affect the decision making differently, however the "reversed" U hypothesis is disputed, so it is still an ongoing question how the decision making is affected by physical activity. According to numerous studies it is clear that these factors are deteriorating under heavy workload. The reaction time slows down and the accuracy is deteriorating. So I have made my questions accordingly:

1. *How the decision making ability is changing with different workloads amongst grown athletes?*
2. *What are the effects of different workloads on simple decision making exercises reaction times amongst grown athletes?*
3. *How the decision making ability is affected by a heavy workload amongst grown athletes.?*
4. *How the reaction time is affected by a heavy workload amongst grown and youth athletes?*

Methods

Participants

There were 53 active adult athletes in the study in which 33 people (21,7 years ± 3,5 years) created the intervention group and 20 people (22,7 ± 2,3 years) consisted in the control group. Within the intervention group 16 people are closed skill sports athletes (athletics), and the others (17) are open skill sports athletes like basketball, martial arts etc. The open skill groups included first league players who were provided by Falco Vulcano KC and Szombathelyi Egyetemi Sportegyesület (SzoESE), where numerous notable and national team selections are playing. There were martial artist too, who came from Controll (kick-box). The closed-skill individual athletes were provided by Szombathelyi Dobó SE and the Haladás VSE. The control group consisted university students from the local university's sports faculty. (football, volleyball, athletics, gymnastics)

The conduct of the measurement

After the arrival of the participants, we recorded their height and then we carried out a body mass analysis. After that that we applied the transmitter beacons (Polar H10, HRTS) onto their chest and a few minutes later we recorded the resting pulse rate. An open source "WinPsycho 2000" (https://webzone.ee/winpsycho) reaction timing test software were used to record the decision making ability, which used a color and speed-discrimination tests to measure (Thomson, et al., 2008; Thomson, 2010).

The control group participants were standing on the treadmill without doing any movements, while the intervention group were experiencing workload on the treadmill during the examination. The study began with 5x1 km walking without any inclination and continually the pace was increased in 2 minutes intervals by 2km/h and 4' inclination, while the participants reached the aerob pulse zone[RER (Respiratory Exchange Ratio) ≥0,75], and eventually reaching the anaerob pulse zone by increasing the workload.(RER > 1,0) (Wasserman, et al.,). After that the athletes were required to run 1 more minute (RER >1,0), and then we progressively lower the treadmill's speed and inclination to zero. We have been constantly recorded the pulse rate and breathing activity during the operation. Those measuring tools were calibrated before the exercises. The "WinPsycho 2000" color and speed-discrimination test was included a task in which a participant had to make decisions related to colors (blue, green, red, yellow) which were flashing up randomly (12x) and the reaction speed was measured.

The second exercise was about fast reaction, where a virtual ball was approaching to the participant (12 times) with different speed (fast, slow). The participant had to push one bottom of the possible two bottoms of the mouse according to a determined rule (left or right bottom) The examined people did the two cognitive exercises four times. We started to record the reaction time and the failures at the start point and then continued after one minute in the aerobic zone, one minute after to step into anaerobic zone and finally two minutes after the end of the physical exercise. To ensure to synchronitiy of the controll and the intervention group, we took the average pressure time of the intervention group (aerobic-anaerobic zone) for the controll group. Heart rate has been recorded before and after every cognitive exercise, all together 8 times, just like int he inretvention group.

Equipments and tests during the research

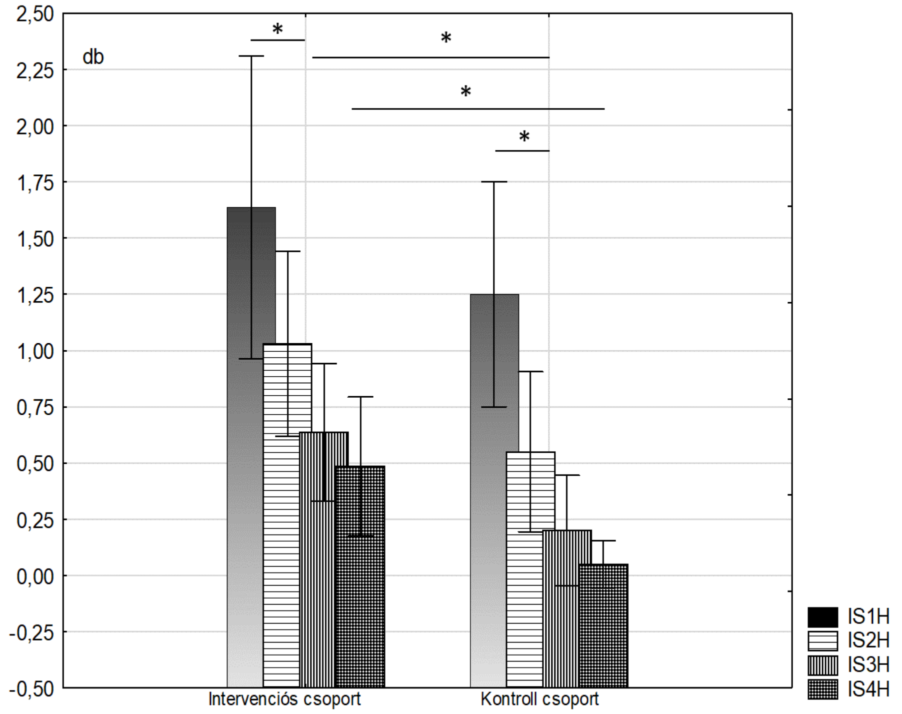
- InBody 720" (Biospace Co. Inc., Soul, South-Korea) type bioimpedance equipment for the measure of body composition, weight (kg), relative body fat (%) and absolute body muscle (%)
- "Marquette 2000" (Pittsburgh, PA, USA) type treadmill with „Vita maxima" pressure protocol (Buchheit, 2008)
- H/P Cosmos LE200CE (DE 83365 Nussdorf-Traunstein Germany) type equipment to follow up the cardiorespiratoric changes of the sportmen
- „Polar H7 Bluetooth 4.0 Smart" (Lake Success, NY, USA) thoracal beacon to follow up the heart rate before, during and after pressure
- Master Screen CPX 50/60 Hz type (CareFusion Germany 234 GmbH 97204 Hoechberg) equipment to measure the rest (Po), (beat.min–1) and maximal heart rate,(Mp) the aerob capacity (VO2max) and the ventillation. VE (BTPS l·min–1)
- Win Pscycho 2000 cognitive testsystem to examine the cognitive skills. The developer, Kaivo Thompson gave his written permission for the research. We used colour and speed perception test and recorded the reaction time and failures both cases (Thomson, 2010).
- Acer Extensa 5220 (U.S. Patent Nos 4,631,603)laptop for the Win Psycho software.
- Epson LCD (H719B, 3-5, Owa 3 chome, Suwa-shi, Nagano-ken 392-8502 Japan) type projector
- Hama Gaming Mouse „uRage Unleashed WL" (Hama GmbH & Co KG D-86652 Monheim) type computer mouse for the test

Statistic assay

We used „Statistica for Windows" 13.2 program to analyse the datas. The compare the antropomerical (DA, TM,TS), body compsosition (F%) and circulation (Po, Pmax) features between the two groups, we applied two pattern t-probe. The colour and speed perception of the two group with the failures and reaction time in different zones have been analysed with ANOVA Post hoc, Tukey (HSD) method. Accidental failure $p<0.05$.

Results

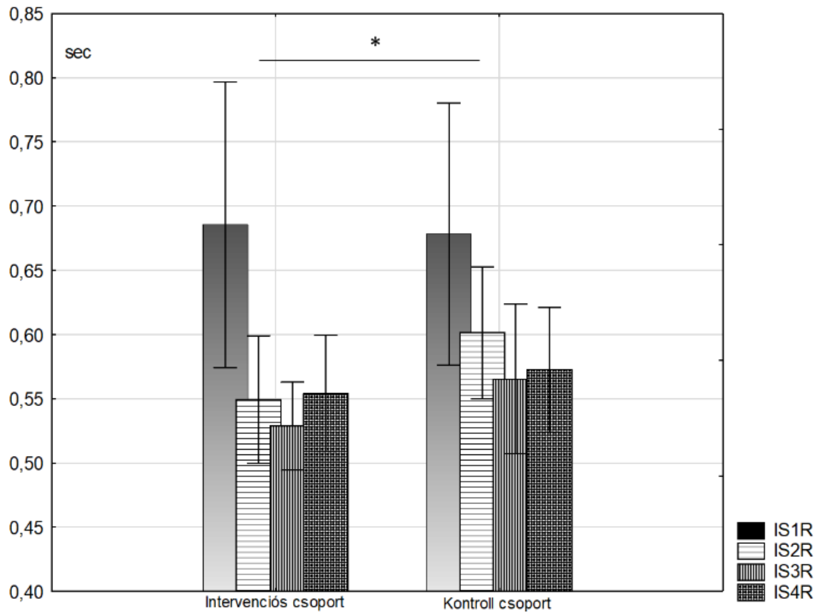
In case of colour perception failures both group produced continous improvement, but participants, who were doing physical exercise int he aerobic zone, made significant more mistakes (ICS3-KCS3= 0,64 pc - 0,20 pc, p=0,03, 1. image). It is a legitimation for Chamura's result (1994), which is about the detoration of cognitive performance during aerobic pressure.



1. *figure: Comparision of colour perception between the two groups.(average ± spread)*

Abbreviations: (IS1H)= before pressure, (IS2H)= aerobic zone, (IS3H)=aerobic breakpoint, (IS4H)=after pressure t<30 sec., (ICS)= intervention group and (KCS) = controll group in rest position.

In case of speed perception the intervention group has made more failures in the aerobic zone, so the result of decision-making was depend on the pressure level. It proves the result of McMorris and Graydon (2000). Aerobic pressure had a positive affect on reaction time during colour perception, we found a significant difference between intervention and controll group (ICS2-KCS2= 0,55 sec. - 0,6 sec., p=0,05, 2. image). On other levels of pressure we haven't found significant difference between the two groups, so anaerobic pressure haven't worsened the reaction time.



2. *figure: Comparision of colour perception between the two groups.(average ± spread)reaction time*

Rövidítések: (IS1R)= terhelés előtt, (IS2R)= aerob tartományban, (IS3R)=az anaerob törésponton, (IS4R)=a terhelés után t<30 sec., (ICS)= intervenciós csoport, illetve (KCS) = kontroll (nyugalmi helyzetben) rögzített négy vizsgálat eredményei.

We haven't found significant difference in reaction time of speed perception, so physical pressure hasn't influenced reaction time. After examining all of the datas after physical pressure, we have found significant difference just in colour perception (ICS4-KCS4= 0,48 db - 0,05 db, p=0,02, 1. image) It a similar result like the research of Smith (2016) about the worsening of cognitive skills during intensive physical pressure.

We have found effective,but not real tendency in reaction time of speed perception. It proves the results of Thomson (2009) about worsening reaction time during intensive physical activity.

Conclusions

To summarise our research we can determine that the anaerobic pressure has a negative effect on cognitive skills in our intervention group with adult professionals. Anyway, in case of colour perception we have found remarkable individual differences, so we can say that professionals' simple decision-making is different in disparate pressure zones. Consequently it is useful to examine decision-making skill during physical pressure, because it can be the key of success in open movement ability sports. Another important result is efficiency and reaction time of decision-making skill has worsened right after physical pressure. It's a useful information for professional sport, because elongation of regeneration time can help to improve the efficiency and reaction time of decision-making skill.

I would like to extend the research to the other sex and age groups in the future. I also would like to examine the changing of decision-making skill during pressure in older age groups. I have worked with closed and opened movement ability sport professionals and amateurs during my research. The difference between the groups are presumably by reaction time and efficiency of decision-making skill. I would like to prove this comparison in the future.

Examination of the Decision-making skill amongst adolescents athletes. – 2. research

Aim and questions.

Similar, like adult athletes, our research goal was to examine how does different physical pressure effect on simple decision-making skill and reaction time amongst adolescents. Beside these question we were curious about the changing of well-being and arousal during intensive physical activity. Our research questions are:

1. *How does decision-making skill change during different pressure zones amongst adolescents?*

2. *How does diffenerent physical pressure effect on reaction time of simple decision-making skill amongst adolescents?*
3. *How does simple decison-making skill change after intensive physical pressure in case of adolescents?*
4. *How does reaction time of simple decison-making skill change after intensive physical pressure in case of adolescents?*
5. *What kind of individual differences of simple decision-making skill can be seen in different pressure zones amongst adolescents?*

Methods

Participants

We have involed to this part of the research 18 adolescents (13,44 ± 0,51 yo), who were male, active basketball players. Exclusion condition were discoloration and the lack of valid medical license. Every participants has given their written permission before the test. We have used the same equipment park as amongst adult athletes.

Measurement

The participants have taken part in three measurements. The first was a pressure test on treadmill, where we have detected their well-being, arousal and heart rate („A" condition). The second test was a measurement in rest, where we have detected well-being, arousal, heart rate and simple decision-maing skill („B" condition). The third test was the mixture of the first and the seconf test, where we examined simple decision-making skill under pressure („C" condition)

In case of „A" condition we have done body composition measurement after record the height. After that we have fastened the thoracal beacon (Polar H10, HRTS) and ascertain the rest pulse before the test. We have calculated the working pulse of the aerobic zone, at the anaerobic breakpoint and in maximal pressure (60-85-100% of maximal heart rate) with the help of Karvonen-formule according to relative rest heart rate (Dömötör, 2005). After the calculation we have examined the well-being and arousal on treadmill and on chair.(well-being scale: Hardy & Rejeski, 1989, arousal-scale: Svebak & Murgatroyd, 1985). After one minute we have repeated againt he well-being and arousal test, then started the physical pressure ont he treadmill. The protocol was the following, the pressure sartred with 6 km/h walk, zero incline for two minutes. Then we have raised the speed with 2 km/h and 2% inclination in every two minutes (maximal inclination 4%), till the adolescent have raised the maximal heart rate. After that we have reduced the speed and inclination till the treadmill stopped.

During the test we were following up the chaning of the heart rate continously. When the heart rate reached the previously calculated levels (60-85-100% of Pmax) we have carried out the well-being and arousal tests. After the well-being and arousal test on the pressure peak we have stopped the treadmill (20 sec) and repeated the two tests. After the stop of the treadmill the participant have sat ona chair for 3 minutes (rest time) and then asked about their well-being and arousal forthe last time.

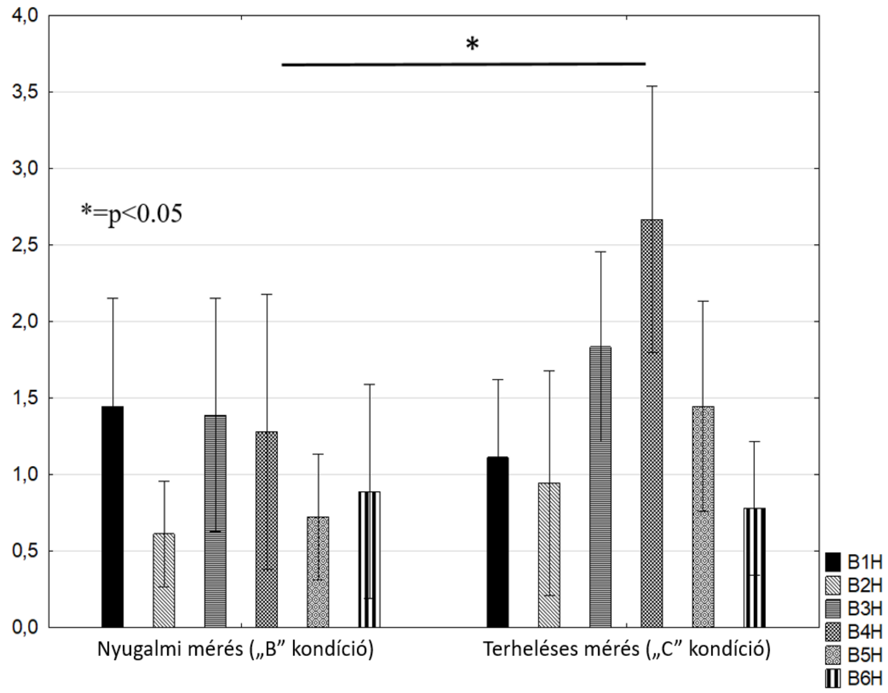
In case of „B" condition we have fastened the thoracal beacon (Polar H10, HRTS) and after some minutes we have recorded the rest heart rate. Then we exaimed their well-being, arousal and decision-making skill while stand on the treadmill in rest, we recorded the reaction time and number of failures (WinPsycho 2000 „Color perception"). A terheléses vizsgálat átlag időközeit felhasználva elvégeztük még 5 alkalommal a korábban leírt teszteket. A vizsgálat alatt folyamatosan nyomon követtük a pulzus változását. A vizsgálat végén levettük a mellkasi jeladót.

A „C" kondíciónál, vagyis a terheléses döntéshozatali vizsgálat lebonyolítása során minden a terheléses vizsgálathoz hasonlóan zajlott, azzal a kivétellel, hogy ebben az esetben már nem kellett elvégezni a testmagasság és test összetétel mérését, valamint a korábbi terheléses vizsgálat időközeit felhasználva a közérzet és éberségi állapot vizsgálata mellett a résztvevők elvégezték a WinPsycho 2000 színészlelés tesztjét (6 alkalommal). Ebben az esetben is feljegyeztük a választási reakcióidőt és a hibaszámokat

Eredmények

A serdülők mindkét fizikai terhelése során, a felnőttekéhez hasonlóan, a terhelés hatására folyamatosan nőtt a pulzus a maximális pulzusig, vagyis a terhelés csúcsáig, míg a nyugalmi mérés esetében a döntéshozatali teszt indukált szűk (10 ütés·perc–1), tartományban, szabályosan ingadozó pulzust mértünk.

A fizikai terhelés során az aerob tartományban, valamint az anaerob törésponton nem találtunk valódi különbséget a nyugalmi méréshez képest, tehát nem javult a döntéshozatali eredményesség, de a maximális terhelés közelében több mint kétszer annyit hibáztak a gyermekek (2,7 db), mint a nyugalmi kondíció (1,27 db, p=0,019) azonos mérésén (3. ábra).



2. *ábra: A két kondíció színészlelési hibaszámainak összehasonlítása (átlag ± szórás)*
Rövidítések: (B1H)= terhelés előtt, (B2H)= aerob tartományban, (B3H)=az anaerob törésponton, (B4H)=maximális terhelésen, (B5H)=közvetlenül a terhelés után t<30 sec, (B6H)= 3 perccel a terhelés után

Tehát egyértelműen látszik, hogy az anaerob tartományban romlik a döntéshozatal eredményessége. A terheléses és a nyugalmi kondíció reakcióidők között sehol nem találtunk szignifikáns különbséget. Ez alapján, azt mondhatjuk, hogy jelentősen nem volt befolyásoló a fizikai terhelés egyik szakasza sem a választásos reakcióidőre.

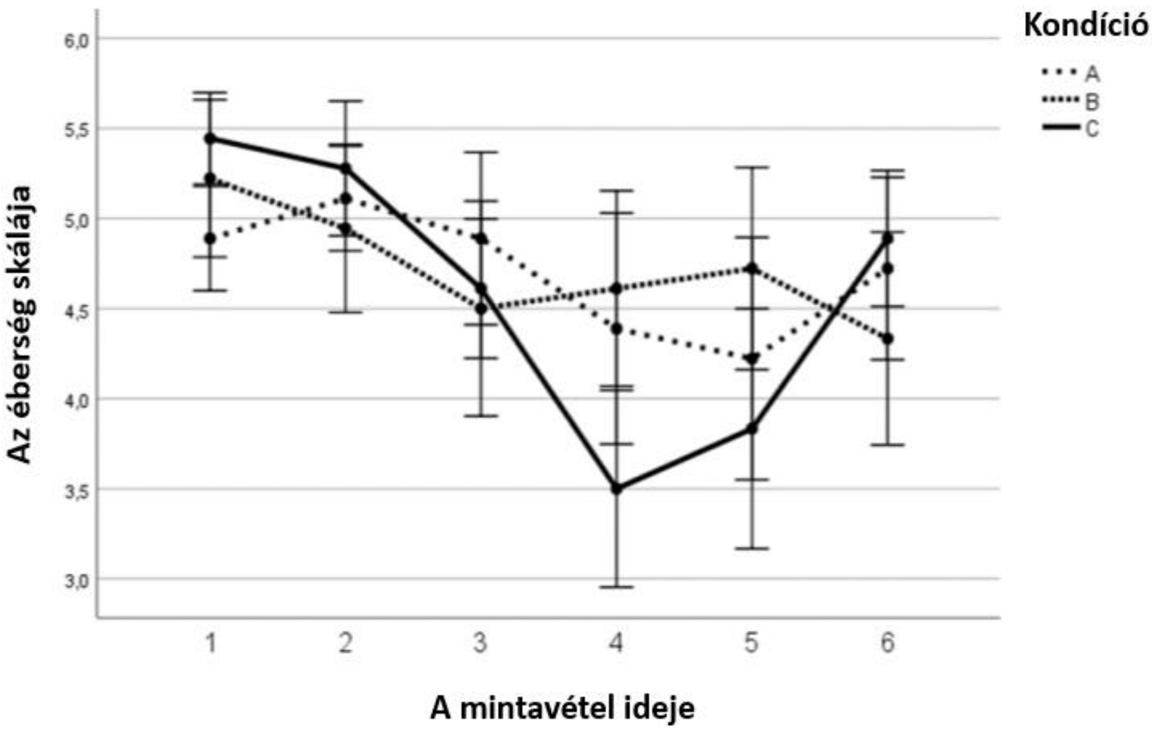
A döntéshozatali eredményesség és a választásos reakcióidő esetében egyaránt jelentős szórás és szélső értékek (0-6 db hiba, 054 -1,21 mp) figyelhetők meg.

1. *táblázat: A serdülők döntéshozatali teszteredményeinek szélső értékeinek bemutatása a „C" kondíció (terheléses mérés) esetében (Saját készítésű táblázat)*

	Döntéshozatali hibaszám (db)		**Döntéshozatali reakcióidő (mp)**	
	Min.	Max.	Min.	Max.
Nyugalmi mérés	0	3	0,46	0,91
Aerob környezet	0	5	0,51	0,85
Anaerob töréspont	0	5	0,47	0,85
Terhelés csúcsa	0	6	0,54	1,21
Közvetlenül terhelés után	0	6	0,49	0,82
Megnyugvás után	0	3	0,51	0,93

Ebből látszik, hogy a vizsgált gyermekek eltérő módon reagáltak a fizikai terhelés kiváltotta helyzetre. Volt, akinek jelentős mértékben megugrottak a hibaszámai a terhelés hatására, de volt olyan, aki sokkal kevesebbet hibázott. A terhelés után közvetlenül és a három perces megnyugvást követően sem találtunk szignifikáns különbséget a nyugalmi kondícióhoz képest a hibaszámok és a választásos reakcióidő esetében.

Ami az közérzet átlagokat illeti, szignifikáns ($p<0.05$) különbséget találtunk az „A" (nyugalmi), és a „B" (fizikai aktivitás, kognitív feladat nélkül) kondíciók között, az anaerob törésponton (3. mérés) a maximális terhelésen (4. mérés) valamint közvetlenül a terhelés után (5. mérés). Mind a három esetben jelentősen rosszabb volt a gyermekek közérzete, amikor fizikai terhelésnek voltak kitéve. A „C" kondíció (fizikai terhelés kognitív feladattal) esetében szignifikáns különbséget nem találtunk egyik terhelési szinten sem, tehát a döntéshozatali feladat elterelte a gyermekek figyelmét a terhelés által kiváltott közérzet romlásról. Jól látszik a 4-es ábrán, hogy az aerob terhelés még kevésbé (2. mérés), az anaerob töréspont (3. mérés) és a tiszta anaerob terhelés (4. mérés) jelentősen rontja a gyermekek közérzetét. A nyugalmi időt követően azonban számottevően javul a közérzet (6. mérés).



3. ábra: Az éberség változása a három kondíció tekintetében (átlag ± szórás)

Következtetések

A serdülők esetében szembetűnő eredmény, hogy a maximális pulzus környékén számottevően romlott a döntéshozatali képesség eredményessége. Emellett, jelentős eltérések figyelhetők meg egyénenként a terhelés különböző szakaszaiban. Ez alapján levonható a konklúzió, hogy serdülők esetében is fizikai terhelés közben érdemes vizsgálni a döntéshozatali képességet. Az egyénenkénti eltéréseket magyarázhatja az, hogy az anyagcsere-szükségletek nem mindenki számára azonosak egy adott edzésintenzitás mellett, így a pszichológiai válaszreakciók is eltérőek lehetnek.

A korábbiakból fakadóan az eredményeket egyeztetve a szakirodalmi ismeretekkel, egyértelmű, hogy sportágválasztás szempontjából a serdülőkkel alkalmazott mérési protokoll alkalmas a gyermekek döntéshozatali képességének vizsgálatához. A döntéshozatali képesség mellett, fontos összetevője volt vizsgálatunknak, a serdülők közérzeti és éberségi állapotának vizsgálata fizikai terhelés közben. Az eredményekből arra következtetésre juthatunk, hogy a serdülők közérzete számottevően romlik a nagyon erős fizikai terhelés hatására, de ezt a közérzet romlást enyhítheti egy kognitív feladat alkalmazása, vagyis elvonja a figyelmüket a kellemetlen érzésekről, ha valamilyen gondolkodást igénylő feladatot kapnak. Ez nagyon fontos lehet mind az élsport mind az iskolai testnevelés számára.

A jövőben szeretném összehasonlítani a felnőtt és a serdülő korosztály eredményeit, de ez alapos körültekintést igényel, hiszen a felnőttek 2 féle döntéshozatali tesztet végeztek el az összes alkalommal, míg a gyermekek 1-et. Így az esetleges különbségek akár ebből is fakadhatnak, mindazonáltal úgy gondolom összehasonlíthatók az aerob terhelési zóna és az anaerob törésponton mért döntéshozatali hibaszámok valamint reakcióidők. Úgy vélem, hogy lehetnek különbségek ezekben a változókban, mivel a felnőtt sportolók, már „rutinosabban" kezelik a fizikai és mentális terhelést (gyorsabb és könnyebb adaptáció az adott fizikai terheléshez), mint a serdülő gyermekek.

Emellett a döntéshozatali képesség fejlesztési lehetőségeivel is szeretnék foglalkozni, hiszen már adott e képesség vizsgálatára alkalmazható mérés. Érdemes lenne megvizsgálni, hogy a különböző korosztályokban milyen sportágspecifikus kognitív feladattal lehet a leghatékonyabbam fejleszteni a döntéshozatal.

Final conclusions and new results

The main goal of my PhD thesis was to give help to the PE teachers to manage more conscious the pressure and sport choice of the children. I would like to draw attention to well-being changes, specialties of decision-making, individual differences during intensive physical activity, as well as we have to give prominence to cognitive skills beside the antropometrical features during sport choice. Hereinafter i would like to summarize the useful conclusions for education sciences. One of the main goals in PE lesson is to form the sport claim, so the qualification and knowledge of the teachers about the cardioresperiatorical and pscyhical changes are especially important . Anaerobic and maximal pressure worsen children’s well-being and make revulsion for sport. On the other hand aerobic activity improves well-being, so it is important to organize the lessons according to this fact. Mindemellett jelentős egyéni eltérések figyelhetők meg, ezért elengedhetetlen a differenciálás. Nevertheless there are significant individual differences, so differentiation is essential.

Children will keen on sport with bigger chance with the consideration of these components. After that it is worthy to suggest a sport to the children, where they can be successful and make sport with lust. My method about the decision-making skill give help to it.

New results

1. We have developed a complex decision-making test under physical pressure.
2. Adolescents have made significantly more failures in aspect of decision-making around maximal pressure
3. There are significant individual differences amongst adolescents in reaction time and success of decision-making.

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