Deutsche
Sporthochschule Köln
German Sport University Cologne

ACSM Annual Meeting
World Congress on ExeRcise is Medicine®
World Congress on The Basic Science of Energy Balance
May 31 – June 4, 2016 Boston, Massachusetts

About exercise recommendations to relax your brain

Vera Abeln[1], Timo Klein[1+2], Julia Peter-Krull[1], Stefan Schneider[1+2]
[1]Institute of Movement and Neurosciences, German Sport University Cologne, Germany
[2]Faculty of Science, Health, Education and Engineering, University of the Sunshine Coast, Maroochydore, Queensland, Australia

ABSTRACT

In todays population stress and psychological diseases are on the rise. To support mental health, exercises should be recommended which reduce electrocortical arousal especially within the prefrontal cortex (executive functions). Because a decrease of prefrontal brain cortical activity was revealed following running exercise in runners but not bicycling, arm-cranking or isometric strength exercise (Brümmer et al. 2011), it was hypothesized that exercise preference, adaptation or running characteristics might play a role for the post-exercise effect on brain cortical activity.

PURPOSE: The present study aimed to check the preference/adaptation hypothesis by testing a group of triathletes, who are adapted to both running and bicycling, but who prefer one of the two exercises. A group of hockey players running but during a competitive match will confine the effect of running characteristics.

METHODS: 10 professional triathletes were asked to perform two modes of triathlon (bicycling and running), each at their individual self-chosen intensity under field conditions (STUDY TRIATHLETES). 24 professional hockey players (n=12 active, n=12 passive) were tested during a competitive match (STUDY HOCKEY). Electroencephalography (EEG) was recorded under rest conditions before (PRE) and after (POST) exercise. Low-resolution brain electromagnetic tomography (LORETA) was applied to localize current density ($\mu V^2/mm^4$) of the frontal, parietal, occipital and temporal lobe.

RESULTS: In triathletes, brain cortical activity decreased following running exercise within the frontal ($p< .001$) lobe. No differences were found for bicycling exercise. Comparing the trials of the preferred with non-preferred mode revealed no difference for all regions of interest (frontal $p= .943$, occipital $p= .438$, parietal $p= .987$, temporal $p= .664$). In hockey players, no significant differences between PRE and POST brain cortical activity and between active and passive players were found.

CONCLUSION: The triathlete study supports that the effect of exercise on brain cortical activity is not dependent on adaptation but running itself. The exercise preference hypothesis could not be confirmed. The hockey data suggests that steady rather than interval running is making the difference. Steady running should be recommended to support mental health. Further studies are required for verification.

INTRODUCTION

The prefrontal lobe of the brain is known to predominately process executive functions (cognition, attention, memory, action and emotional regulation). Reduced activation (decreased activity) within this area is assumed to reflect decreased arousal and stress, and might increase mental health. In our population, interventions to reduce stress and to support mental health are highly needed, especially in regard of the increasing numbers of people suffering from stress symptoms and disorders. Previous studies support the notion that the relaxing effect of exercise on brain cortical activity is dependent on exercise preference or adaptation (Brümmer et al. 2011, Schneider et al. 2009). Within a group of recreational runners, running exercise resulted in decreased frontal brain activity, whereas bicycling, arm-cranking and isokinetic strength exercise did not. Furthermore, it remains unclear whether interval running has the same effect as steady running.

METHODS

TRIATHLETES

10 male professional (Bundesliga) triathletes participated (age: 23.11±2.61 years; height: 183.00±7.05 cm; weight: 71.75±5.87 kg; VO_2max running: 58.69±3.75 $mL \cdot min^{-1} \cdot kg^{-1}$; VO_2max bicycling: 58.21±7.09 $mL \cdot min^{-1} \cdot kg^{-1}$, >16.6 training hours/week). An incremental bicycle exercise test was performed in advance in order to obtain the individual VO_2max and to rate the performed exercise intensity. **EEG**, heart rate **(HR)**, capillary blood lactate concentration **(LAC)** was measured pre exercise, post0, post15, and post30. Ratings of perceived exhaustion **(RPE)** was requested after exercise. Exercise **distance** and **time** was assessed using Garmin Forerunner 310XT (Garmin, Schaffhausen, Switzerland). 7 triathletes preferred to run, 3 preferred to cycle.

HOCKEY

24 male professional (Bundesliga, >5 training hours/week) hockey players (age: 23.5±7.5 years; height: 184.10cm; weight: 76.88 kg) were divided into an active (participating in competition, n=12) and passive group (watching the competition, n=12). **EEG** was recorded pre and approximately 60min post exercise. Mean heart rate **(HR)** was calculated from recordings during the match using a team heart rate monitoring system (acentas GmbH, Hörgertshausen, Germany).

None of the participants reported any psychological or physiological problems or previous head injuries or was taking medication. All signed a written informed consent.

Resting-EEG (Brain Products GmbH, Munich, Germany) was measured for 5 minutes using 32 electrodes or for Hockey using 16 electrodes according to the 10:20 System (Jasper, 1958). Each electrode was referenced to a ground (AFz) and a reference electrode (FCz) which are included in the cap design mounted in the triangle of FP1, FP2 and Fz. Analysis was performed using the Brain Vision Analyzer Software (Brain Products). The data was filtered (high-low-pass: 0.9 to 10Hz, time constant 0.177sec, notch filter 50Hz), baseline corrected and segmented into 4sec intervals allowing a 10% overlap. Independent component analysis (ICA) was used to remove eye blink artifacts. An automatic artifact rejection was applied for the detection of artifacts. Activity within frontal, temporal, parietal and occipital lobes was exported using low-resolution electromagnetic tomography (LORETA) (Pascual-Marqui 1994). EEG activity was exported as logarithm naturalis of current density values ($LN(\mu V^2)$).

For each study, differences of parametric variables between groups (Triathletes: bicycling vs. running; Hockey: active vs. passive) and measurement times (pre, post (0, 15, 30)) were calculated by ANOVA for repeated measures respectively (STATISTICA 7.1, StatSoft, Tulsa, USA). Significance threshold was $p< 0.05$. Fisher LSD post-hoc test was used in case of significance. For non-parametric values (RPE), Wilcoxon Test and Friedman´s ANOVA was used.

RESULTS

TRIATHLETES

PARAMETER	TIME	UNIT	TRIATHLETES Bicycling	TRIATHLETES Running
HR	PRE	[bpm]	59.80 ± 7.41	60.00 ± 7.80 ^{*15}
HR	POST0	[bpm]	119.40 ± 5.82 $^{*pre,15,30, run}$	124.30 ± 17.03 $^{*pre,15,30, bike}$
HR	POST15	[bpm]	68.00 ± 11.04	68.90 ± 8.67
HR	POST30	[bpm]	65.10 ± 9.31	64.30 ± 8.74
LAC	PRE	[mmol/l]	1.17 ± 0.20 ^{*15,30}	1.18 ± 0.16
LAC	POST0	[mmol/l]	1.38 ± 0.31 ^{*15,30}	1.55 ± 0.18
LAC	POST15	[mmol/l]	1.05 ± 0.11 ^{*run}	1.10 ± 0.35 ^{*bike}
LAC	POST30	[mmol/l]	0.91 ± 0.10 ^{*run}	0.93 ± 0.26 ^{*bike}
RPE			12.00 ± 1.56	12.20 ± 1.03
distance		[km]	43.24 ± 13.40 ^{*run}	7.60 ± 2.71 ^{*bike}
time		[min]	88.12 ± 24.10	36.01 ± 12.57
EEG frontal	PRE	[μV^2]	-6.26 ± 0.34	-6.12 ± 0.54 ^{*0,15,30}
	POST0	[μV^2]	-6.38 ± 0.48^{*run}	-6.81 ± 0.41 $^{*bike\ pre}$
	POST15	[μV^2]	-6.42 ± 0.50^{*run}	-6.70 ± 0.36 $^{*bike\ pre}$
	POST30	[μV^2]	-6.38 ± 0.50^{*run}	-6.80 ± 0.49 $^{*bike\ pre}$
EEG temporal	PRE	[μV^2]	-5.59 ± 0.28	-5.41 ± 0.46 $^{*bike\ pre}$
	POST0	[μV^2]	-5.78 ± 0.49	-6.13 ± 0.53
	POST15	[μV^2]	-5.78 ± 0.53	-6.02 ± 0.53
	POST30	[μV^2]	-5.71 ± 0.55	-6.04 ± 0.58
EEG parietal	PRE	[μV^2]	-6.17 ± 0.28	-5.41 ± 0.46 $^{*0.15.30}$
	POST0	[μV^2]	-6.38 ± 0.53	-6.34 ± 0.54
	POST15	[μV^2]	-6.04 ± 0.56	-6.27 ± 0.52
	POST30	[μV^2]	-6.00 ± 0.59	-6.33 ± 0.58
EEG occipital	PRE	[μV^2]	-5.45 ± 0.34	-5.65 ± 0.50 $^{*0.15.30}$
	POST0	[μV^2]	-5.64 ± 0.50	-5.86 ± 0.52
	POST15	[μV^2]	-5.59 ± 0.50	-5.82 ± 0.62
	POST30	[μV^2]	-5.46 ± 0.55	-5.79 ± 0.69

Table 1: Results of the exercise interventions (bike, run) of group TRIATHLETES for the parameters heart rate (HR), lactate concentration (LAC), ratings of perceived exhaustion (RPE), exercise distance and time, and EEG activity within the frontal, temporal, parietal and occipital lobe.

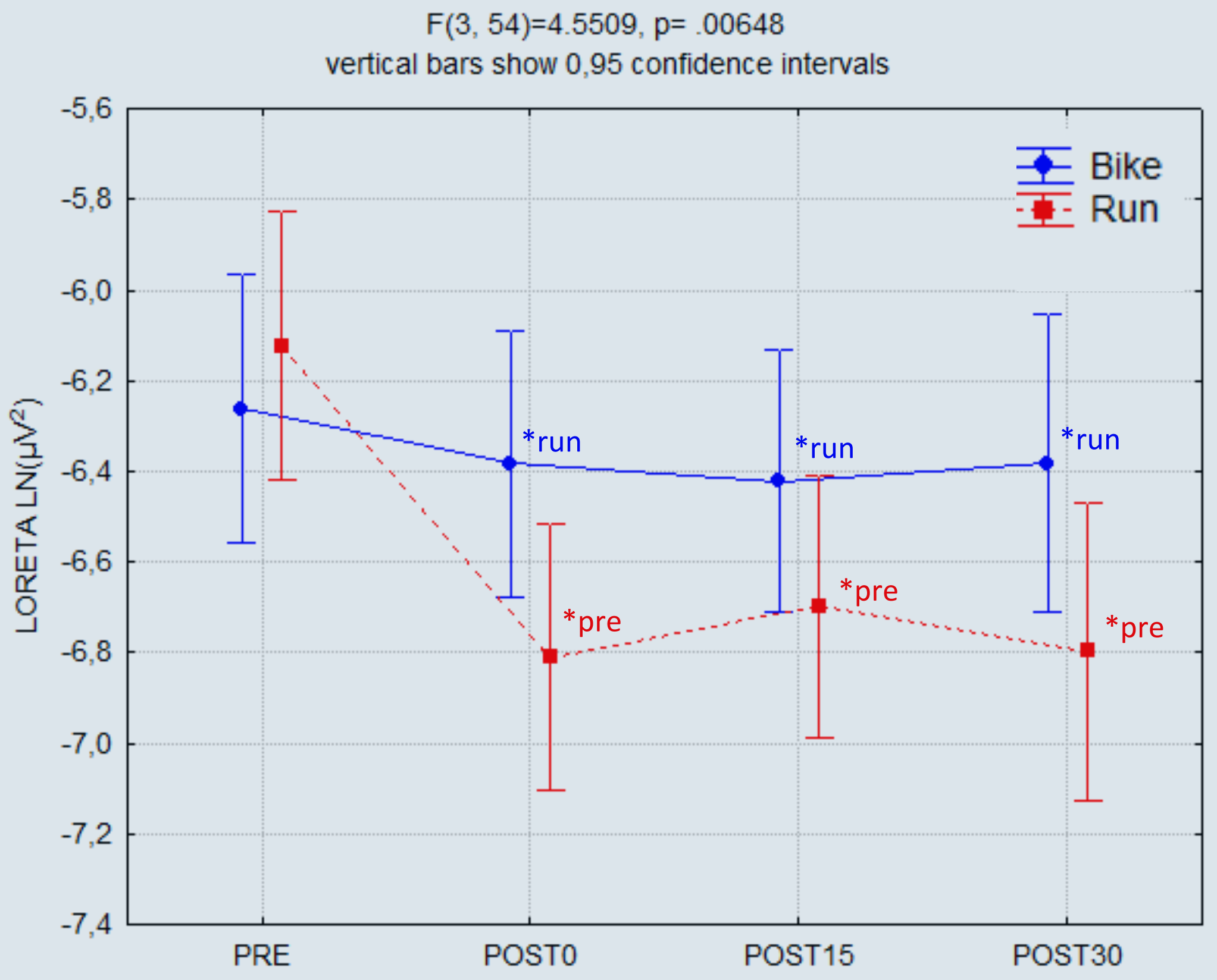

Figure 1: Results TRIATHLETES frontal EEG activity for running and bicycling exercise.

PARAMETER	TIME	UNIT	TRIATHLETES non-preferred	TRIATHLETES preferred
EEG frontal	PRE	[μV^2]	-6.16 ± 0.49	-6.23 ± 0.40
	POST0	[μV^2]	-6.59 ± 0.59	-6.60 ± 0.59
	POST15	[μV^2]	-6.59 ± 0.41	-6.53 ± 0.50
	POST30	[μV^2]	-6.60 ± 0.56	-6.58 ± 0.51

Table 2: Results TRIATLETHES frontal EEG activity for the **preferred** vs. non-preferred exercise of group (F (3,54)= 0.19391, p= 0.90).

HOCKEY

Table 3: Results of groups hockey (active, passive) for the parameters heart rate (HR), and EEG activity.

PARAMETER	TIME	UNIT	HOCKEY active	HOCKEY passive
HR	Mean during match	[bpm]	151.00 ± 14.05 ^{*passiv}	87.10 ± 13.65 ^{*active}
EEG frontal	PRE	[μV^2]	-8.10 ± 0.44	-7.62 ± 0.35
	POST	[μV^2]	-7.88 ± 0.64	-7.75 ± 0.44
EEG temporal	PRE	[μV^2]	-6.52 ± 0.72	-6.28 ± 0.35
	POST	[μV^2]	-6.36 ± 0.68	-6.09 ± 0.66
EEG parietal	PRE	[μV^2]	-7.36 ± 0.63	-6.84 ± 0.28
	POST	[μV^2]	-7.08 ± 0.59	-6.94 ± 0.52
EEG occipital	PRE	[μV^2]	-7.03 ± 0.70	-6.62 ± 0.40
	POST	[μV^2]	-6.81 ± 0.63	-6.48 ± 0.66

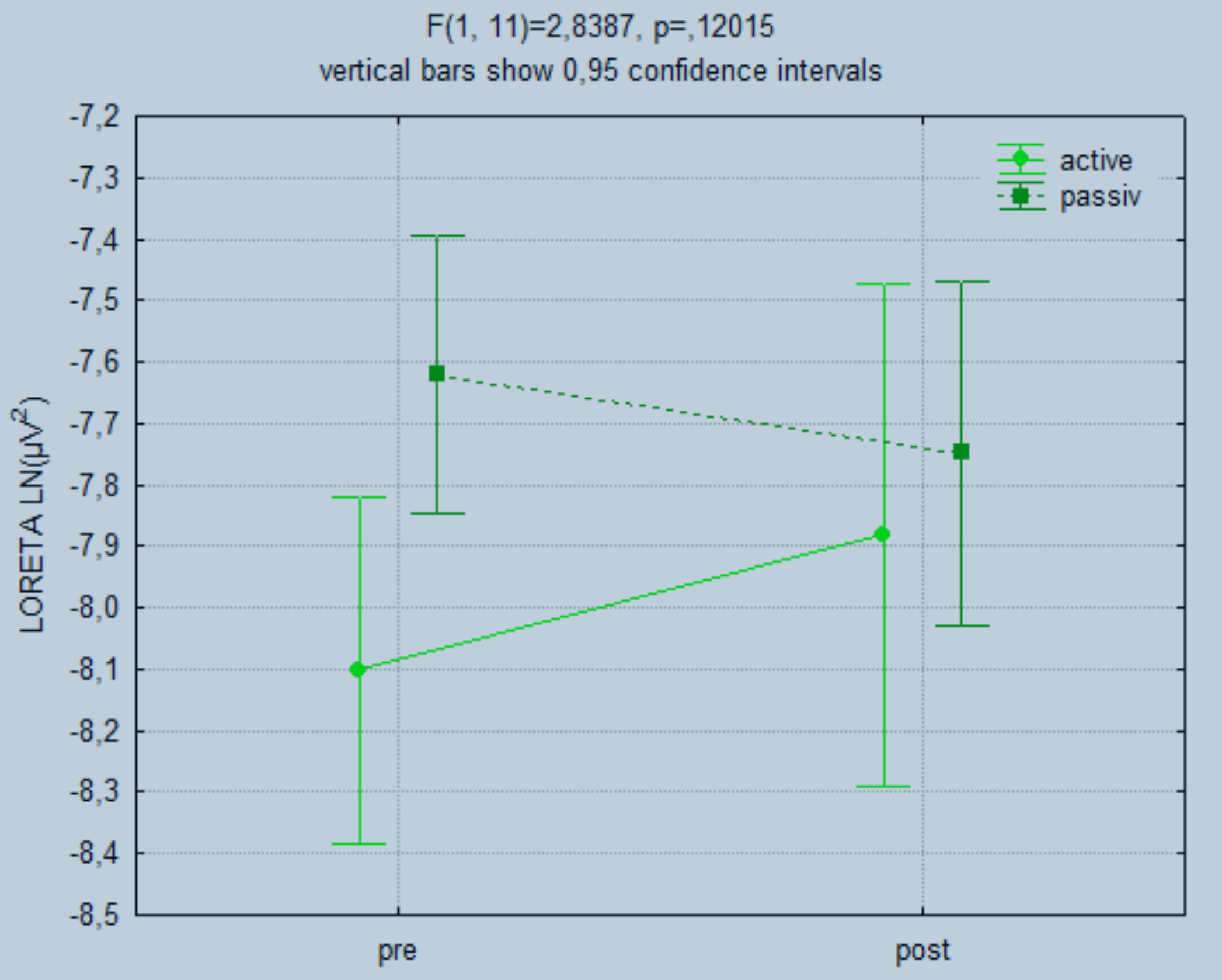

Figure 2: Results frontal EEG activity for the active vs. passive group of hockey players for the measurement times (pre, post).

DISCUSSION

There was no difference between running and bicycling exercise for HR, RPE and exercise time, whereas LAC and exercise distance differed within the group of triathletes due to the nature of the sports (Tab. 1). Both exercises were performed at about 60% of the individual VO_2max. However, continuous running other than bicycling exercise resulted in a decreased global brain activity post exercise in the group of triathletes (Tab. 1 + Fig. 1). Frontal lobe activity was significantly lower post running exercise compared to post bicycling exercise. There was no effect of exercise preference within this group (Tab. 2). Within the group of hockey players the interval-like running exercise during a competitive match (group active) did not result in significant changes of EEG activity. The passive control group did also show no significant differences (Tab. 3 + Fig. 2).

Study limitations are the unequal distribution of exercise preference of the triathletes, the limited number of participants as well as the difference of measurement times and participants between the two studies. Further studies are required for verification.

CONCLUSION

The triathlete study supports that the effect of exercise on brain cortical activity is <u>not</u> dependent on adaptation or exercise preference. The hockey data suggests that steady rather than interval running is making the difference. Steady running exercise seems to make the difference for the effect on brain cortical activity and was again proven to result in a deactivation (relaxation) especially within the prefrontal cortex. Because of the prefrontal cortex is known to host brain regions with executive functions, steady running should be recommended to support mental health.

References:
Brümmer V, Schneider S, Abel T, Vogt T, Strüder HK. (2011) Brain cortical activity is influenced by exercise type and intensity. MSSE Oct;43(10):1863-72. **Jasper HH.** The ten-twenty electrode system of the international Federation. *Electroencephalogr Clin Neurophysiol Suppl*. 1958;10:371-5.; **McGovern RA & Sheth SA.** (2016) Role of the dorsal anterior cingulate cortex in obsessive-compulsive disorder: converging evidence from cognitive neuroscience and psychiatric neurosurgery. J Neurosurg. Apr 1: 1-16. **Pascual-Marqui RD, Michel CM, Lehmann D.** Low resolution electromagnetic tomography: a new method for localizing electrical activity in the brain. *International journal of psychophysiology : official journal of the International Organization of Psychophysiology*. 1994;18(1):49-65.

This study has been funded by an internal research grant of the German Sport University Cologne

CONTACT: v.abeln@dshs-koeln.de