Neuroscienze e ginnastica

Lo stato della letteratura scientifica

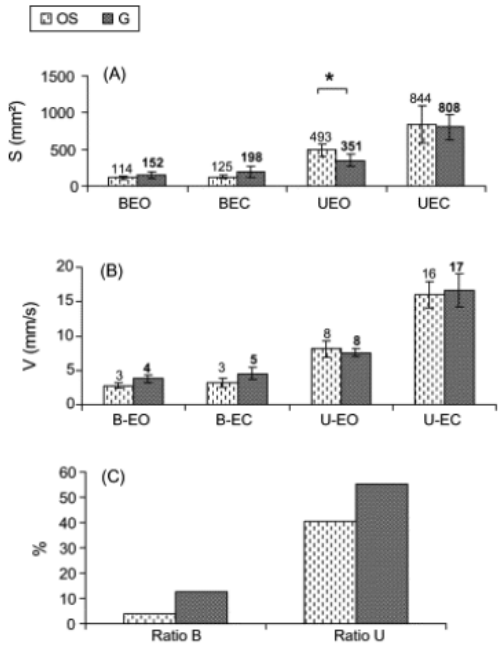
Revisione della letteratura a cura di: Marco Ivaldi, PhD

Asseman, F. B., Caron, O., & Crémieux, J. (2008). Are there specific conditions for which expertise in gymnastics could have an effect on postural control and performance?. Gait & posture, 27(1), 76-81.

Are there specific conditions for which expertise in gymnastics could have an effect on postural control and performance?

Expertise in gymnastics seemed to improve postural performances only in situations for which their practise is related to. These reveal the importance of choosing a relevant postural configuration and visual condition according to the people's training or by extension experience.

Necessità di fornire esercitazioni di natura posturale anche in situazioni diverse da quelle performative abituali. Bisogna prevedere esercitazioni ad occhi chiusi.



Carrick, F. R., Oggero, E., Pagnacco, G., Brock, J. B., & Arikan, T. (2007). Posturographic testing and motor learning predictability in gymnasts. Disability and rehabilitation, 29(24), 1881-1889.

Posturographic testing and motor learning predictability in gymnasts.

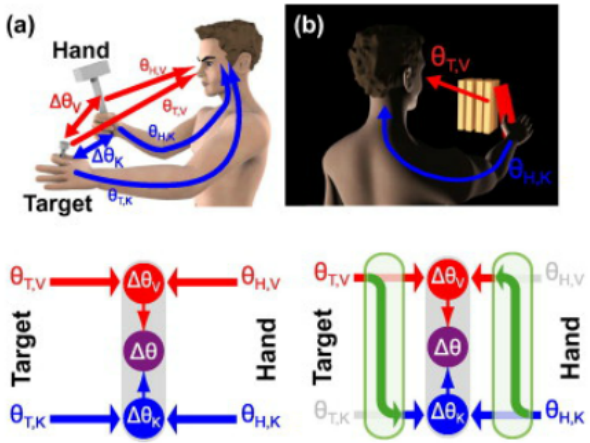
While gymnasts have greater postural integrity than do non-gymnasts, CDP can identify individuals whose ability to perform new motor activities might be impaired. Methodology to improve functional stability not associated with the motor task may contribute to increased sports performance and decreased probability of injury.

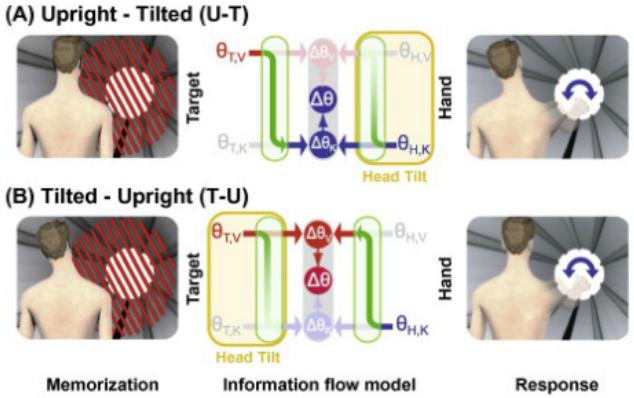
Esercitazioni per l'equilibrio e l'adattamento posturale non associati con i compiti motori usuali possono incrementare la performance e diminuire la probabilità di infortunio

Tagliabue, M., Arnoux, L., & McIntyre, J. (2013). Keep your head on straight: Facilitating sensori-motor transformations for eye–hand coordination. Neuroscience, 248, 88-94.

Keep your head on straight: facilitating sensori-motor transformations for eye–hand coordination

Results suggest that the reason humans tend to keep their head upright may also have to do with how the brain manipulates and stores spatial information between reference frames and between sensory modalities, rather than only being tied to the specific problem of stabilizing visual and vestibular inputs.



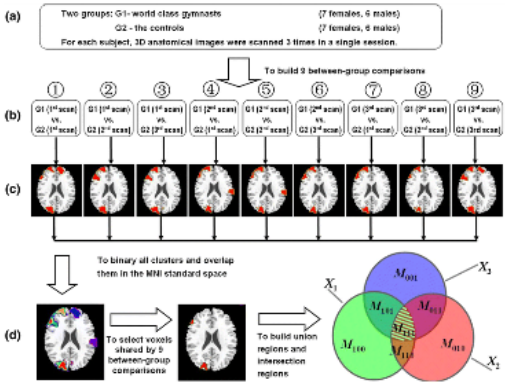


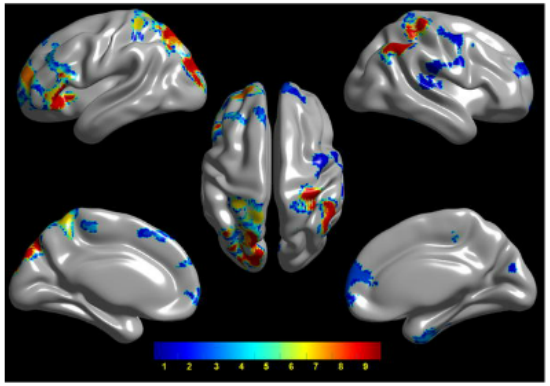
La posizione del capo è legata alla modalità in cui il cervello processa le informazioni spaziali e le afferenze sensoriali

Huang, R., Lu, M., Song, Z., & Wang, J. (2015). Long-term intensive training induced brain structural changes in world class gymnasts. Brain Structure and Function, 220(2), 625-644.

Long-term intensive training induced brain structural changes in world class gymnasts

We speculate that the brain changes of the WCG may reflect the gymnasts' extraordinary ability to estimate the direction of their movements, their speed of execution, and their identification of their own and surrounding objects' locations. Our findings suggest that our method of constructing intersecting regions from multiple between-group comparison can considerably reduce the false positives, and our results provide new insights into the brain structure changes induced by long-term intensive gymnastic training.



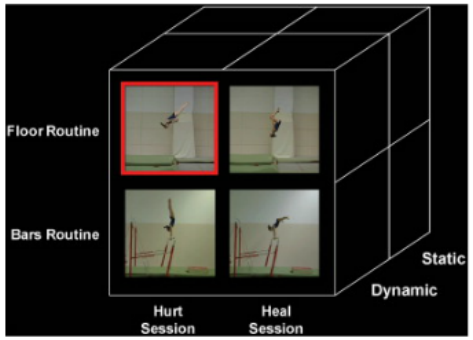


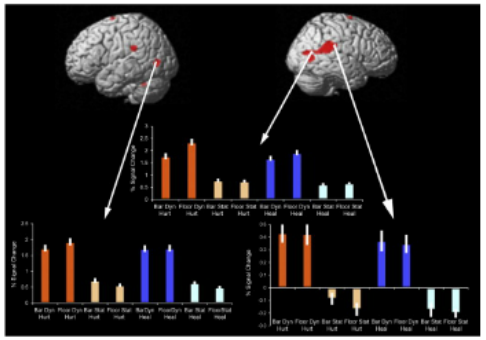
L'allenamento intensivo e a lungo termine produce cambiamenti nella struttura cerebrale dei ginnasti.

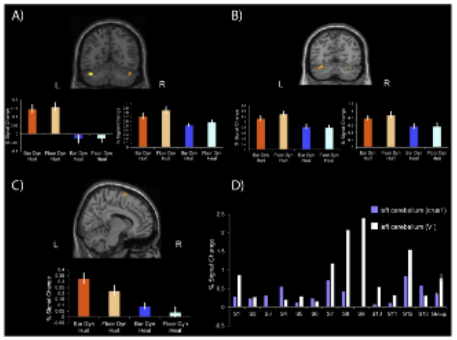
Calmels, C., Pichon, S., & Grèzes, J. (2014). Can we simulate an action that we temporarily cannot perform?. Neurophysiologie Clinique/Clinical Neurophysiology, 44(5), 433-445.

Can we simulate an action that we temporarily cannot perform?

The equal contribution of MT/V5/EBA and inferior parietal lobule during the observation of movements the gymnasts were able or unable to practice suggests respectively that physical provisional incapacity does not interfere with the perceptual processing of body shape and motion information, and that motor expertise may prevent the decay of sensorimotor representations. Higher activations in the cerebellum may suggest that this structure plays a role in dissociating perceived physically feasible movements from those that are provisionally unfeasible.





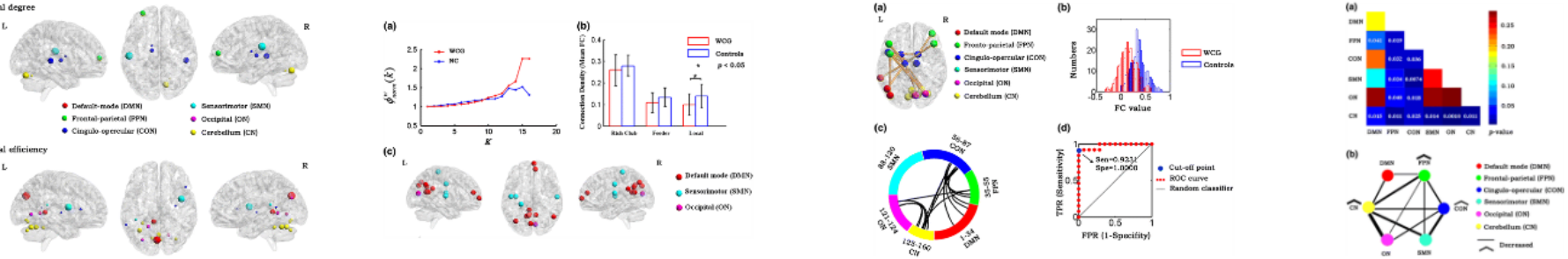


L'osservazione del movimento permette di mantenere una corretta elaborazione percettiva della forma del corpo e delle informazioni motorie anche se il movimento per infortunio non si può svolgere.

Wang, J., Lu, M., Fan, Y., Wen, X., Zhang, R., Wang, B., ... & Huang, R. (2016). Exploring brain functional plasticity in world class gymnasts: a network analysis. Brain Structure and Function, 221(7), 3503-3519.

Exploring brain functional plasticity in world class gymnasts: a network analysis.

Results suggested that functional plasticity can be detected in the brain functional networks of WCGs, especially in the cerebellum, fronto-parietal network, and cingulo-opercular network. In addition, we found that the FC between the fronto-parietal network and the sensorimotor network was significantly negatively correlated with the number of years of training in the WCGs. These findings may help us to understand the outstanding gymnastic performance of the gymnasts and to reveal the neural mechanisms that distinguish WCGs from controls.

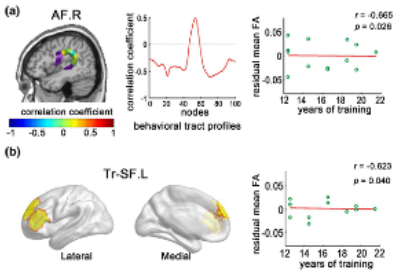


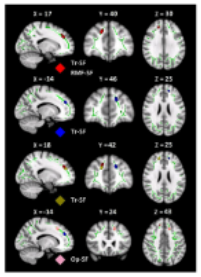
Il numero di anni di pratica è correlato con le reti neurali funzionali sviluppate, soprattutto nel cervelletto.

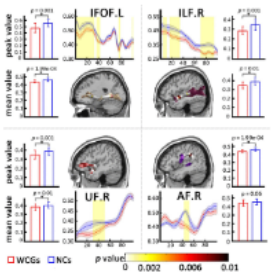
Deng, F., Zhao, L., Liu, C., Lu, M., Zhang, S., Huang, H., ... & Wang, J. (2017). Plasticity in deep and superficial white matter: a DTI study in world class gymnasts. Brain Structure and Function, 1-14.

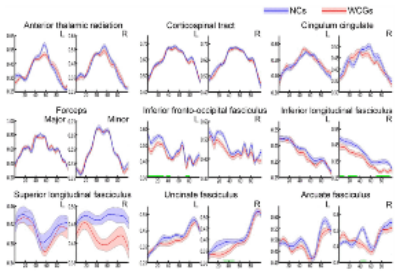
Plasticity in deep and superficial white matter: a DTI study in world class gymnasts.

Brain white matter (WM) could be generally categorized into two types, deep and superficial WM. Studies combining these two types WM are important for a better understanding of brain plasticity induced by motor training. Classification analyses indicated FA in deep WM hold higher potential to distinguish the gymnasts from the controls. Overall, our findings provide a more complete picture of training-induced plasticity in brain WM.







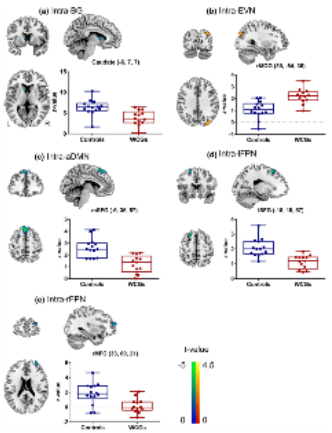


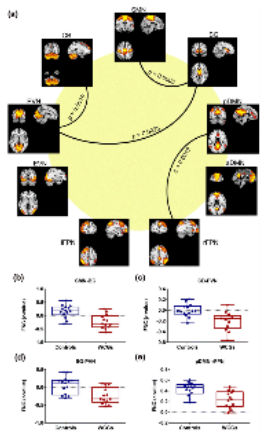
L'addestramento motorio induce plasticità cerebrale

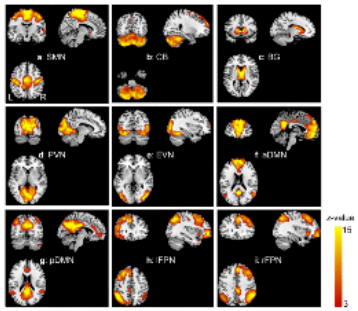
Huang, H., Wang, J., Seger, C., Lu, M., Deng, F., Wu, X., ... & Huang, R. (2018). Long-term intensive gymnastic training induced changes in intra-and inter-network functional connectivity: an independent component analysis. Brain Structure and Function, 223(1), 131-144.

Long-term intensive gymnastic training induced changes in intra- and inter-network functional connectivity: an independent component analysis.

Long-term intensive gymnastic training can induce brain structural and functional reorganization. Previous studies have identified structural and functional network differences between world class gymnasts (WCGs) and non-athletes at the whole-brain level. However, it is still unclear how interactions within and between functional networks are affected by long-term intensive gymnastic training. We interpret this generally weaker intra- and inter-network functional connectivity in WCGs during the resting state as a result of greater efficiency in the WCGs' brain associated with long-term motor skill training.







L'allenamento intensivo a lungo termine può indurre una riorganizzazione strutturale e funzionale del cervello come risultato di una maggiore efficienza nel cervello associato ad un allenamento a lungo termine per l'abilità motoria.

It is thus increased understanding of both the effects of sleep deprivation and potential mechanisms of influence on performance that may allow scientists and practitioners to positively influence sleep in athletes and ultimately maximize performances.

Ivaldi, M., Cugliari, G., Fiorenti, E., & Rainoldi, A. (2018). Delta and alpha rhythms are modulated by the physical movement knowledge in acrobatic gymnastics: an EEG study in visual context. Sport Sciences for Health, 14(3), 563-569.

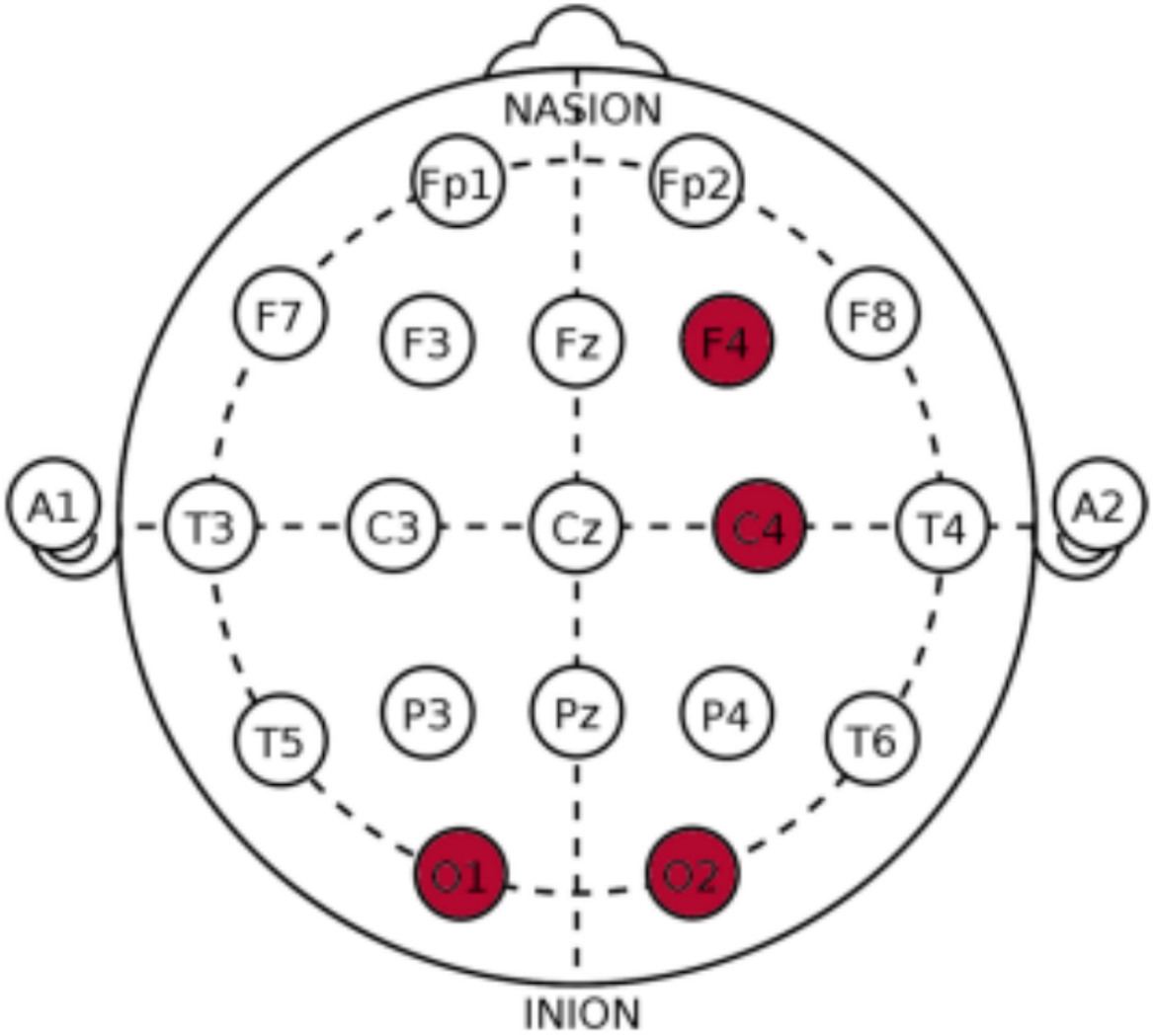
Delta and alpha rhythms are modulated by the physical movement knowledge in acrobatic gymnastics: an EEG study in visual context

Moreover, this study demonstrates how even for a judge the previous motor experience can affect the ability to recognize the correct execution of a complex technical gesture. It may be possible to identify technical progressions based on the correct recognition of the specific technical-motor feedback, highlighted through the EEG analysis.

Finally, experienced athletes recognize the wrong motor actions more easily, this is important to understand the load of neurophysiological fatigue that the unexperienced athletes could undergo during a training session, even if the technical gestures to be learned might seem easy to perform to an expert.

Questi risultati confermano la relazione tra attività EEG e visione di specifici movimenti fisici e
estendono la conoscenza relativamente alla risposta elettrocorticale agli stimoli visivi sottolineando la differenza tra soggetti inesperti ed esperti, relativamente al campo analizzato.

The International 10–20 system scalp map placement for



EEG. Channels with significant differences were highlighted

Considering single channel activation, power spectra highlights statistically significant differences during the comparison between the two groups, at O1, F4, C4 and O2 (Table 1).

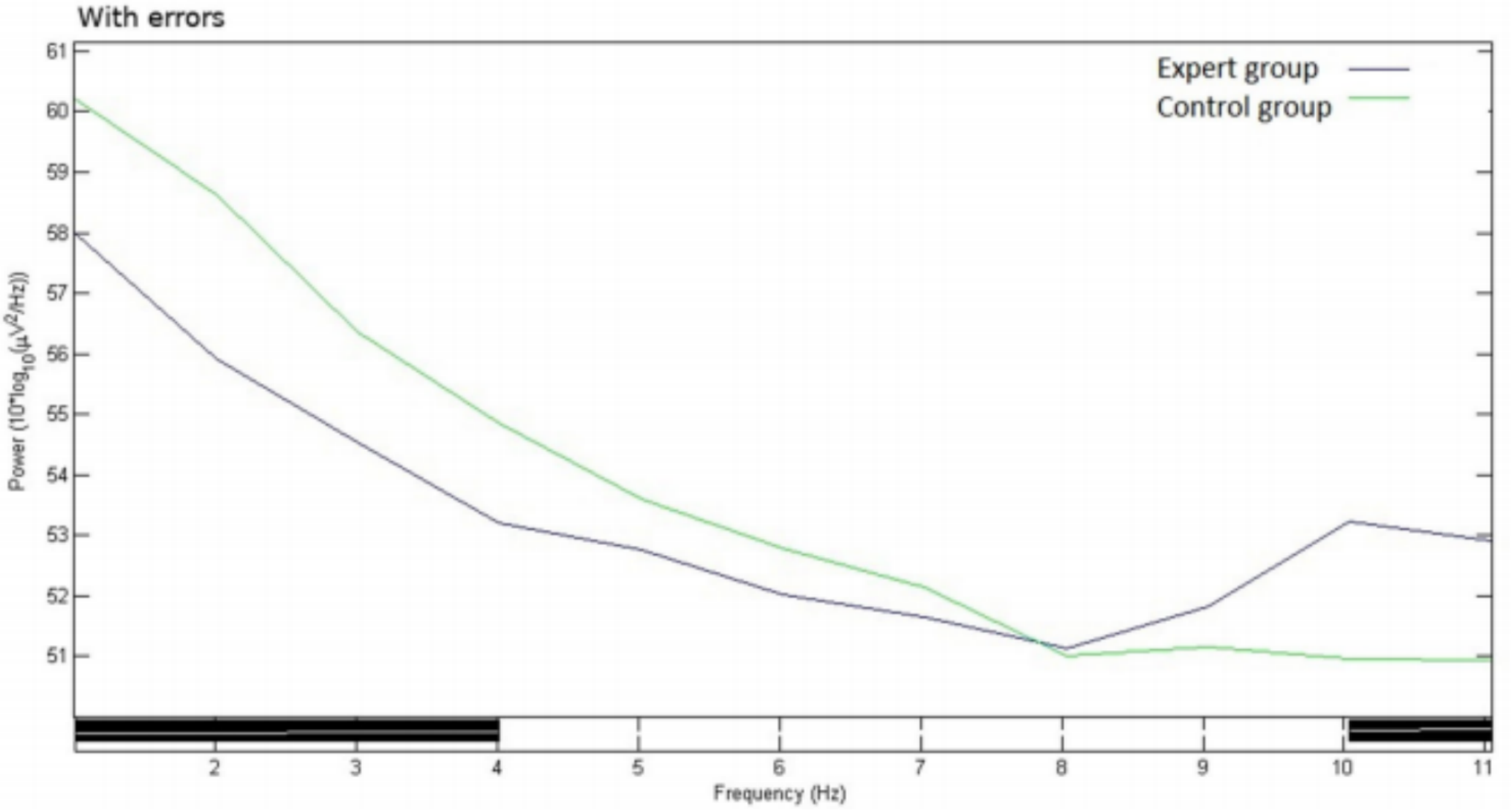


Fig. 1 Power spectra during the vision of the videos with errors, after ICA. Blue line indicates the experienced group and green line the unexperienced group. Statistically significant differences between the two groups are highlighted by the black line on the abscissa

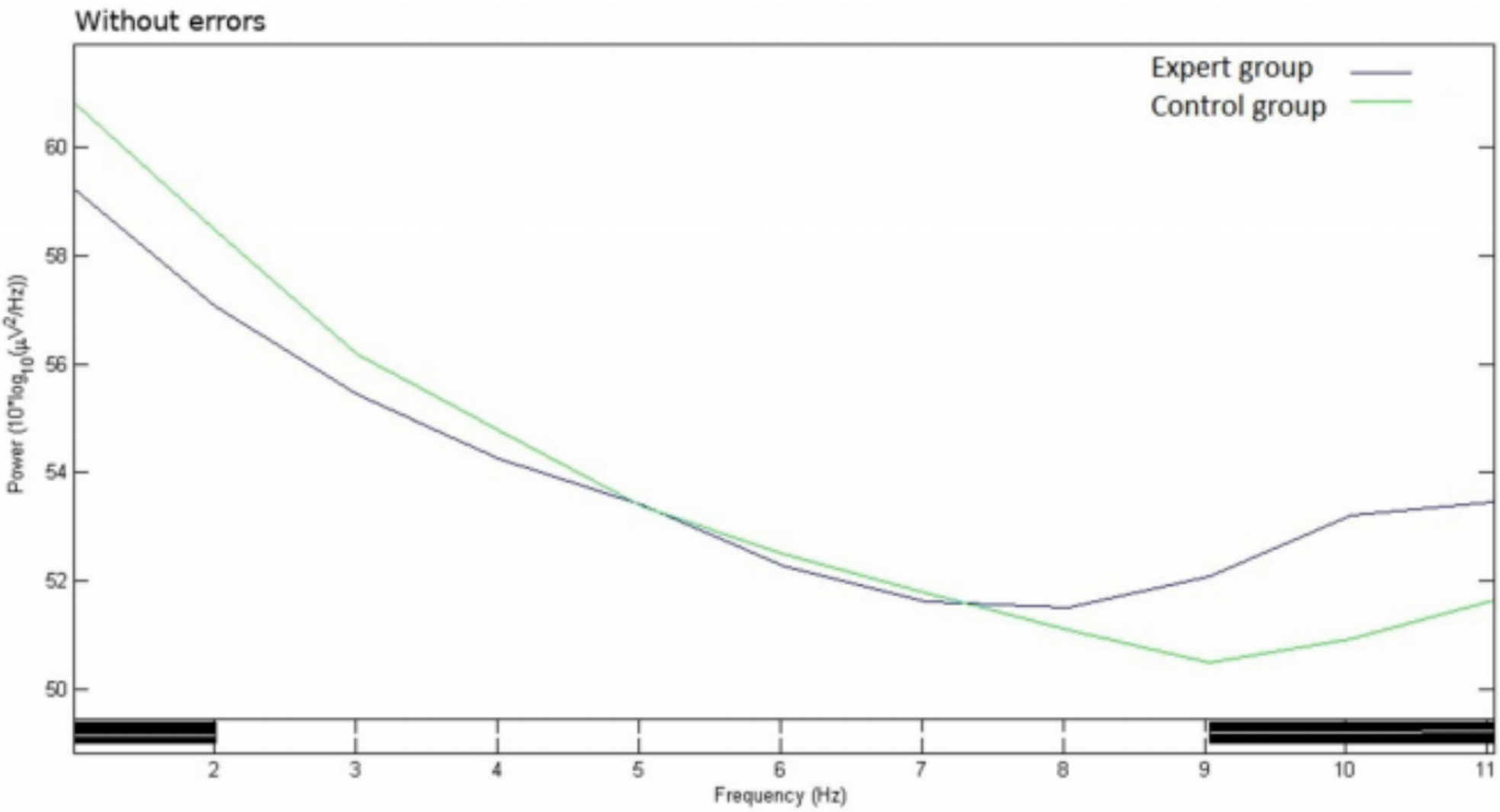


Fig. 2 Power spectra during the vision of the videos without errors, after ICA. Blue line indicates the experienced group and green line the unexperienced groups. Statistically significant differences between the two groups are highlighted by the black line on the abscissa

Table 1 Single channel differences in videos with errors and without errors

Channels	With errors	Without errors
Channel O1	Slow alpha	Slow alpha
Channel F4		Slow alpha
Channel C4	Slow alpha	Delta
Channel O2		Slow alpha

Frequency bands that showed statistically significant differences (p value < 0.05) between the two groups were reported

Take-home message

Spazio di azione condiviso significa mantenere l'atleta in contatto con gli altri atleti, anche nel caso di infortunio

L'apprendimento per imitazione è veloce, efficace, efficiente ed ha una grande learning retention; usare il più possibile modelli imitativi e video.

I neuroni specchio mi permettono di:
a) comprendere l'esecuzione in un modello di apprendimeno per imitazione
b) sfruttare i meccanismi centrali legati all'attivazione neurale anche in caso di infortunio
c) attivare la riprogrammazione dello schema d'azione nel cervelletto

I modelli imitativi agiscono anche verso l'allenatore, i genitori, i modelli sportivi: attenzione a tutti i comportamenti dicotomici

Le tecniche di qEEG permettono, in modo non invasivo, di controllar l'attività centrale degli atleti rispetto a compiti di motion imagery.

Il riconoscimento di errori dipende dall'esperienza dell'atleta, il carico neurale è dipendente dall'esperienza. Perciò è importante riconoscere in funzione dell'esperienza dell'atleta quale lavoro centrale si sta richiedendo

L'utilizzo della musica, soprattutto per atleti esperti, permette di migliorare la motor imagery e la fissazione del gesto sportivo