

# Beyond the clinical use of neurofeedback

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## Editorial

Neurofeedback (NFB) is thought to be a direct training of custom brainwaves in order to make the brain's functionality more efficient. In a typical NFB session, the brain activity is measured with electroencephalography (EEG), from one or more sites according to the used protocol. The subject is rewarded, with acoustic or visual feedback, when his/her brain activity meets the protocol's goals, increasing with that way the probability of this cerebral behavior.<sup>1</sup> Until now the NFB has been successfully used in several domains of psychiatry and neurology,<sup>2</sup> but there is a huge gap in the use of NFB in healthy conditions. The NFB for the brain can be considered as the gymnastics for the body, and it can be used to make the brain more efficient in terms of attention, memory and emotions. Until now there is a limited literature to this direction, revealing that there is a free space for research with both clinical and social impact.

One of the earliest studies,<sup>3</sup> which used two NFB sessions of one hour in healthy participants, revealed that the inhibition of theta's amplitude (4-7Hz) in occipital lobe resulted to an increase in vigilance. Another study<sup>4</sup> increased the beta brainwaves (16-22Hz) and suppressed simultaneously the theta and alpha bands (6-12Hz) for twenty sessions, and they found that those who managed to control their EEG, showed improvement in attention. Vernon and his colleagues<sup>5</sup> trained thirty-two healthy volunteers to either increase their SMR (12-15Hz) or increase their theta activity. The first group enhanced their working memory and focused attention, while the second one didn't depict any significant difference. Increasing SMR is also found to improve accuracy, reduce errors and reaction time as well.<sup>6</sup> Authors of<sup>7</sup> used Peak Alpha Frequency (PAF) in order to train elders for cognitive enhancement. Their results suggest that PAF NFB improved cognitive processing speed and executive function, but they haven't any clear effect on memory's performance. Moreover, the increase of upper alpha band (10-12Hz) seems to be also effective for the improvement of cognitive performance.<sup>8</sup> In the same way a recent study<sup>9</sup> used upper alpha training for five NFB sessions in fourteen subjects. Eleven from fourteen subjects, who succeed in their training, increased their cognitive performance in terms of a mental rotation task. For more information about NFB on optimizing cognitive and affective outcomes you can refer to this review.<sup>10</sup>

Despite the use of NFB for cognitive enhancement we can find studies that connect NFB with performing arts and sports. One of the most extraordinary examples is the Gruzelier's "heavenly" musicians.<sup>11,12</sup> Gruzelier used twenty sessions Alpha/Theta training for the first group, mental skills training and aerobic fitness training for the second group and a passive control group. Only the NFB group showed improvements in performance, found on the scales of overall quality, and encompassing the three domains of performance: instrumental competence, musicality and communication. In the same study Alpha/Theta NFB affected also the performance of ballroom dancers. For more information about NFB and performing arts you can refer to review published in 2013.<sup>13</sup>

NFB is also used in increasing the sports performance by enhancing

the concentration and attention, reducing the anxiety, improving the control over emotions, and overcoming head injuries and traumas. One of the most well-known examples is the Italian football team, where some Italian footballers used NFB to train their focus.<sup>14</sup> A recent study applied NFB in archers, increased SMR and inhibited Theta and high Beta (22-26Hz) bands. After twelve sessions, the NFB group showed significant improvement on archery performance compared with the control group.<sup>15</sup> NFB was also applied on elite female swimmers in order to reduce their anxiety.<sup>16</sup> The protocol used in this study was the increment of SMR and Beta bands, in order to increase their motivation, improve their emotional states, increase their sensorimotor coordination, and develop their mental abilities, while simultaneously they suppressed the high Beta and Theta activities in order to increase their composure. After twelve sessions the NFB group, compared to the control one, demonstrated lower anxiety. For more information about the NFB and its application in sports psychology refer to.<sup>17</sup>

Summarizing all the above we can clearly observe that there is an increasing field for future research in all the presented dimensions of NFB's application in healthy population. The current work reported the main studies of NFB in cognitive, performing and athletic enhancement, underlying the need for more research and awakening the health professionals for the potential use of NFB in healthy people. The Journal of Psychology & Clinical Psychiatry is a promising tool for the debate of NFB's effects in healthy conditions as well as in mental disorders, and it is able to address the ongoing research of NFB with responsibility and scientific accuracy.

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## Conflicts of interest

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