**BMC Neuroscience**

Research article **Open Access**

**Optimizing microsurgical skills with EEG neurofeedback**

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**Abstract**

**Background:** By enabling individuals to self-regulate their brainwave activity in the field of optimal

performance in healthy individuals, neurofeedback has been found to improve cognitive and artistic

performance. Here we assessed whether two distinct EEG neurofeedback protocols could develop

surgical skill, given the important role this skill plays in medicine.

**Results:** National Health Service trainee ophthalmic microsurgeons (N = 20) were randomly

assigned to either Sensory Motor Rhythm-Theta (SMR) or Alpha-Theta (AT) groups, a randomized

subset of which were also part of a wait-list 'no-treatment' control group (N = 8). Neurofeedback

groups received eight 30-minute sessions of EEG training. Pre-post assessment included a skills lab

surgical procedure with timed measures and expert ratings from video-recordings by consultant

surgeons, together with state/trait anxiety self-reports. SMR training demonstrated advantages

absent in the control group, with improvements in surgical skill according to 1) the expert ratings:

overall technique (d = 0.6, p < 0.03) and suture task (d = 0.9, p < 0.02) (judges' intraclass correlation

coefficient = 0.85); and 2) with overall time on task (d = 0.5, p = 0.02), while everyday anxiety (trait)

decreased (d = 0.5, p < 0.02). Importantly the decrease in surgical task time was strongly associated

with SMR EEG training changes (p < 0.01), especially with continued reduction of theta (4–7 Hz)

power. AT training produced marginal improvements in technique and overall performance time,

which were accompanied by a standard error indicative of large individual differences.

Notwithstanding, successful within session elevation of the theta-alpha ratio correlated positively

with improvements in overall technique (r = 0.64, p = 0.047).

**Conclusion:** SMR-Theta neurofeedback training provided significant improvement in surgical

technique whilst considerably reducing time on task by 26%. There was also evidence that AT

training marginally reduced total surgery time, despite suboptimal training efficacies. Overall, the

data set provides encouraging evidence of optimised learning of a complex medical specialty via

neurofeedback training.