Signature changes in human brain wave activity associated with olfactory learning

Previous animal studies have shown that olfactory learning modulates oscillatory activities in the mammalian olfactory system. In trained rodents, odour-induced oscillations in the gamma frequency band (30-80Hz) were specifically amplified in the olfactory bulb (OB) which was also associated with power increases in beta oscillations (15-30Hz) in both the OB and pyriform cortex (PC). However, there is still no evidence that these learning induced oscillations also occur in humans and that is one aim of this study. Additionally, we sought to determine if the drop in detection threshold for androstadienone due to increased sensitization also generalizes to the structurally similar androstenol. We also intended to find out if the induced sensitization to androstadienone results in changes in the perceived odour quality. Here, fourteen normal human subjects with low to intermediate sensitivity to androstadienone were selected for ten day scent trials. By using electroencephalography (EEG), oscillatory response due to androstadienone was predominately recorded in four brain regions on days 0, 3, 7 and 10. The induced oscillations were measured in the OB, PC, right and left frontal hemispheres. A power spectrum technique was used to analyze EEG responses in the gamma and beta frequency bands. Our results showed that learning-induced sensitization to androstadienone amplified gamma power in the OB, however beta oscillations were only enhanced in the PC. Exposure-induced sensitization to androstadienone also generalized to androstenol demonstrating plasticity in the human olfactory system. The induced learning was accompanied with significant changes in the perceived familiarity and intensity of androstadienone. As a whole this is the first study to demonstrate that olfactory learning in humans is associated with an increase in gamma oscillatory power in the OB and beta oscillations in the PC. This might indicate that gamma oscillations are switched to beta waves as they travel a significant distance to the PC.

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