

Ultrasound neuromodulation based on acoustic radiation force induces defensive behavior

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Background, Motivation and Objective

Defensive behavior is the instinct of animals reacting to threats and dangers. Previous studies have suggested that the midbrain periaqueductal gray (PAG) is essential for the generation of defensive response. Ultrasound neuromodulation based on acoustic radiation force has the potential to noninvasively modulate the neuronal activity. This study aims to investigate the effect of ultrasound stimulation of PAG on the defensive behavior in mice.

Statement of Contribution/Methods

The experimental setup was shown in Fig. 1a. C57BL/6J mice (8 weeks old, male) were employed in the experiment. Ultrasound ($f = 3.8$ MHz) with 1 kHz pulse repetition frequency (PRF), 50 % duty cycles (DCs) and 0.18 MPa acoustic pressure, was delivered to the midbrain PAG in awake and free moving mice. Real-time place preference assays were used to assess the modulation effect of LIFUS on PAG. After 10-minute habituation, mice were placed in a custom-made behavioral arena ($50 \times 50 \times 25$ cm black plexiglass) for 10 min. Then, we assigned one counter-balanced side of the chamber as the stimulated side. When an experimental mouse crossed over into the stimulated side, it was stimulated until crossed back into the non-stimulated side. Behavioral data was recorded via a CCD camera interfaced with SMART VIEDO TRACKING software (SMART V3.0.06, Panlab, Harvard Apparatus).

Results/Discussion

Mice spend significantly less time in the stimulated side during the stimulation epoch, while no significant differences are observed on both sides of the chamber during the pretest epoch, as shown in Fig. 1b-c. Significant increment in animals' speed can be found during ultrasound stimulation (Fig. 1d). Our findings demonstrate that ultrasound neuromodulation may enable to modulate PAG on defensive behavior in mice.

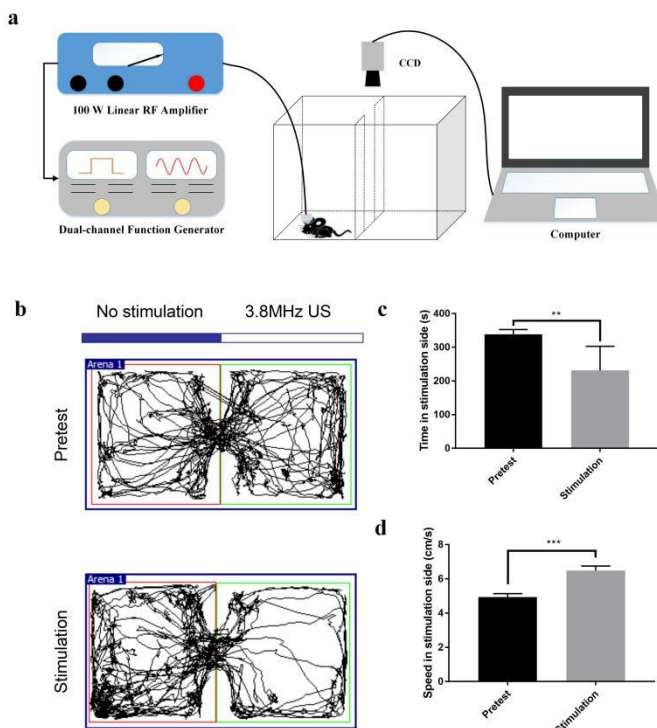


Fig. 1(a) Schematic diagram of experimental setup. (b) Real-time place-preference location plots for a representative mouse show the animal's position over the course of the 20-min session. (c) Time and (d) mean speed in stimulated chamber during pretest and stimulation epochs ($n = 7$, **: $P < 0.01$, ***: $P < 0.001$, paired t-test).