Testing Subcutaneous Electrode Implantation by Building and Receiving the P300 Response

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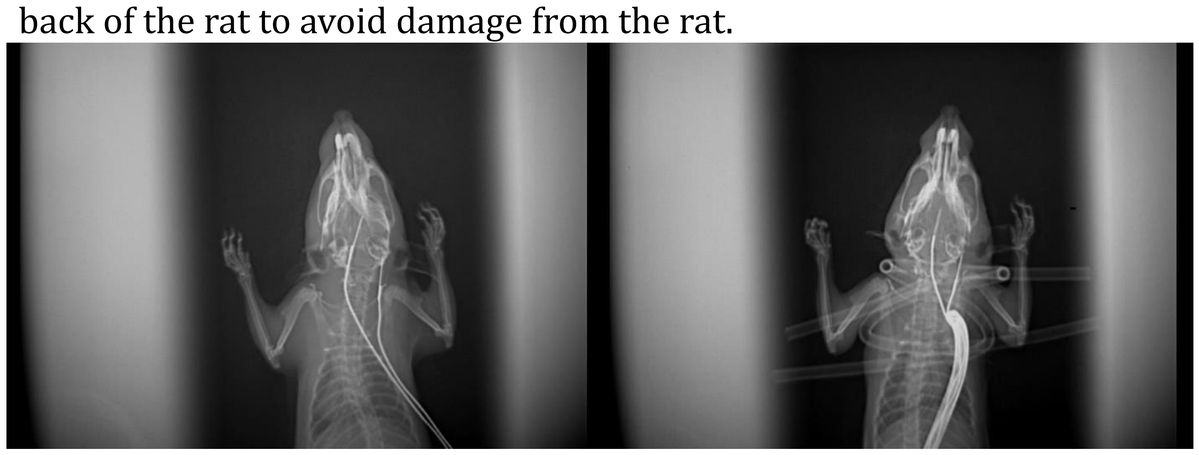
Background

P300 Response is a signal in the brain that occurs approximately 300 milliseconds after receiving meaningful and rare stimuli.
Subcutaneous Electrode Injection is a new method of installing electrodes into rats being tested in this study. It involves inserting electrodes underneath the skin on top of the skull to receive brain waves as opposed to opening the skull to insert electrodes using current methods.
Operant Boxes are special cages designed to block out sound coming from outside of the cage to allow focus on whatever is occurring inside of the box. The operant boxes in this study included a lever, two electrode wire adapters, and a speaker that played one of two tones every six seconds.
Oddball Trials include two tones, with a rare tone that plays <50% of the time being the oddball and a standard tone that occurs >50% of the time.
Goal of the Study: To test the new method of inserting electrodes into rats and determine if this method can provide the same data that current methods can without being as invasive or complex.
Experimental Design: 24 Wistar rats are divided into four test groups of six rats and are tested daily in separate Operant boxes by playing two tones and rewarding them with food for pressing the lever at correct times. The rats are weighed and fed every day based on their current and target weights. Eventually, the rats are implanted with electrodes subcutaneously, tested with the electrodes installed to detect the P300 response, and injected with saline and ethanol.

Installation of Electrodes Subcutaneously

Method: After being given several weeks to learn the oddball program, the rats have electrodes installed underneath the scalp. After being given an isoflurine and oxygen mixture as an anesthetic, the head of the rat is shaved with an electric razor. Then, the rat is injected with carprofen to prevent inflammation and baytril to combat infections. The electrodes are then inserted underneath the skin using a syringe needle to guide the electrode needle through the skin. The reporting electrode is inserted above the Pz region of the brain to detect the P300 response specifically and the reference electrode is inserted posterior to the lambda to receive all other activity. After being inserted, the rat is taken to an x-ray machine and scanned to show where the electrodes have been placed to ensure that they are properly installed. The electrode wires are then wrapped in a coil and secured on the back of the rat to avoid damage from the rat.



Results: The picture above is an x-ray image of a rat with two electrodes successfully installed onto the skull

Conclusion: As both images show electrodes correctly implanted into the Pz region and lambda of the skull, it can be concluded that subcutaneously inserting electrodes can successfully be used for proper electrode installation.

Oddball Trials

Method: 24 rats are tested in four test groups of equal size in individual Operant boxes for 100 to 50 minutes each day in 40-60, 30-70, and 20-80 trials. During these trials, one of two tones are played every six seconds: the standard tone or the rare tone. Rats that press the lever inside of the Operant box in response to a rare tone are rewarded with a food pellet. The names of the trials indicate what percentage of the tones are rare and what percentage are standard. A 40-60 trial has 40% rare and 60% standard, a 30-70 has 30% rare and 70% standard, and so forth. Each of these trials runs daily for two weeks before the next trial was is. As the 20-80 trials begin, the rats are implanted with electrodes that are connected to an amplifier that enhances the weak signals coming from the skull during 50 minute trials. Some rats are also injected with saline or either a 1.5 or 0.75 g/kg ethanol solution to observe its effects on the P300. Data is collected from the electrodes in order to receive the P300 response and graphed on a computer using DataWave software to support the new method of inserting electrodes into rats.

Results:

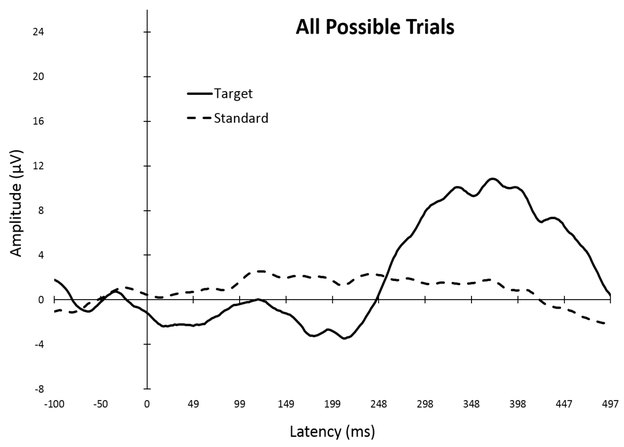
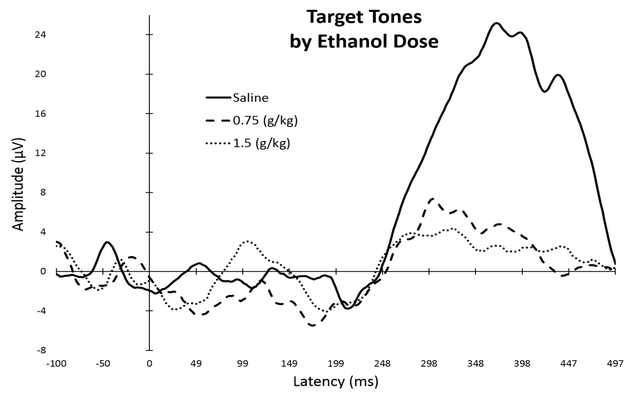


Figure 1. Amplitude of brain activity in response to the rare and standard tone over time measured in milliseconds for all possible trials.

Figure 2. Mean amplitude of brain activity in rats injected with saline or ethanol in response to the rare tone.



Conclusion: Both graphs demonstrate a sharp peak in brain activity about 300 milliseconds after the rare tone is played, thus demonstrating the P300 response and therefore confirming that the electrodes can successfully report brain activity. The data also suggests that doses of ethanol have a great impact on brain activity magnitude.

Conclusion and Future Work

These results show that not only does the surgery procedure effectively install the electrodes and allow brain activity to be recorded, but that ethanol doses have a large impact on the P300 response. Overall, our results suggest that this method of subcutaneously implanting electrodes is a relatively non-invasive and viable option for collecting data in small mammals. In the future, it would be useful to use more durable equipment and eliminate all stimuli except for the two tones, as wires were often damaged and additional stimuli such as lights being activated inside of the box skewed some results.

References

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Acknowledgments

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