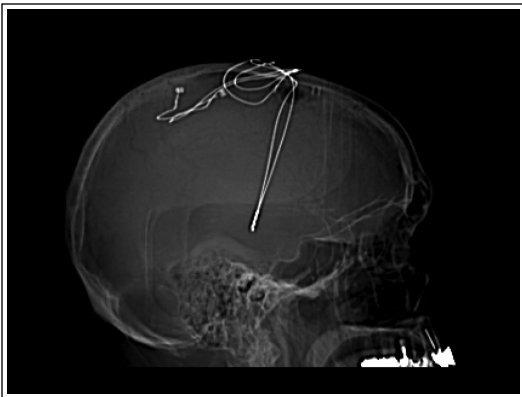


## Introduction

The ability to make predictions about the environment is critical for an organism's survival, and the reward system in mammals is critical to this ability. Various reward centers have been shown to project to the subthalamic nucleus (STN) [1], and recent evidence in animal models suggests that the region is involved with reward expectation [2,3]. Here, we extend these results and specifically test for reward expectation in the human STN.



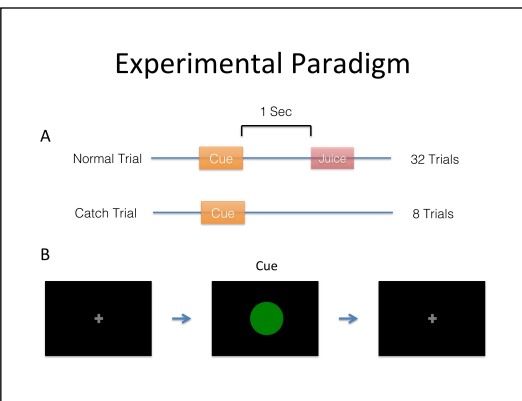
**Figure 1:** An example of a DBS electrode implanted within the STN

## Methods

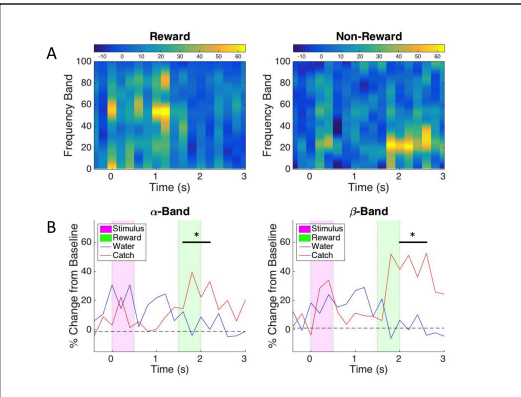
- 11 PD patients participated in our study and had microelectrodes implanted within their STN
- Patients were presented with a visual stimulus, followed one second later by either a reward (32 trials) or nothing (8 trials) (See figure 2)
- The reward stimulus was sugar water (2 drops of ~15 g/L) administered orally via a syringe pump

## Detailed Methods

- To build expectation, the first 10 trials were always rewarded
- Non-rewarded trials were interspersed randomly throughout the remainder of the trials
- Power spectral density (PSD) was computed using Welch's method (segment length = 100 ms; overlap = 50 ms)
- Baseline activity was established using the 3 seconds prior to the trial start
- For individual electrode analysis, each trial was normalized by its baseline activity, then averaged together
- For group analysis, normalized and averaged activity from each electrode was averaged and then compared to baseline



**Figure 2: A.** The timeline for each condition. Both cues and rewards are presented over .5 seconds. In the reward condition, there is a 1 second gap between the end of cue, and when the reward is presented. **B.** The visual cue seen by the patient during the trial.



**Figure 3:** Combined data from 17 electrodes. **A.** Averaged PSD of the reward and non-reward conditions. Colors correspond to the percent change from baseline in power. **B.** PSD in clinically relevant bands. The purple shaded area corresponds to the stimulus presentation, while green corresponds to delivered reward. The starred black bar covers statistically significant increases in the non-reward condition. Note that no region of the reward condition was statistically different from baseline.

## Results

- The STN presents a heterogeneous response, with seemingly different categories of activity
- Approximately 40% of electrodes show more than a 10% increase in beta activity over baseline
- Analyzing only these, we demonstrate a significant and stereotyped response
- Alpha and beta activity increases significantly in the non-reward condition during and after the period when reward was expected but not received (Figure 3)
- Similar but non-significant activity is found in the 100-200 Hz range

## Conclusions

- The STN presents a stereotypical 'reward prediction error response' [4] found in parts of the reward system
- Our study provides additional evidence that STN is strongly integrated with the reward system and not merely responsible for motor information processing

## Future Directions

- Analyze the uncategorized responses for additional stereotyped behavior
- Compare categories of responses with positional data to gain insight into the functional anatomy of the STN

## References

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