Differential Brain Activity During Wins and Losses

A Paired t-Test Analysis Using fMRI

The Martians

Neuromatch Academy©

Summer 2024

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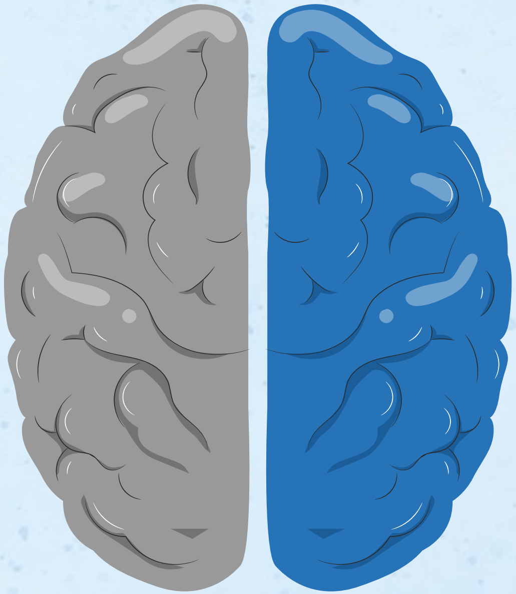


01

OVERVIEW

INTRODUCTION

Gambling behavior, a complex interplay of risk-taking and decision-making under uncertainty, has significant implications for understanding human cognition and mental health. Studying gambling can provide insights into broader neurobehavioral processes, such as impulse control, reward processing, and risk assessment.

Task Explanation

- Card guessing game
- Which card
- How fast

HCP

A brief introduction to the dataset

3 - 3.5 min

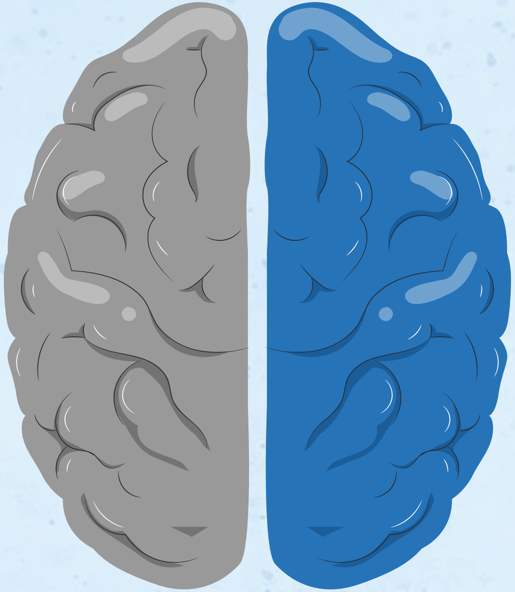
The duration of recording

100

The number of participants

253

The size of time series



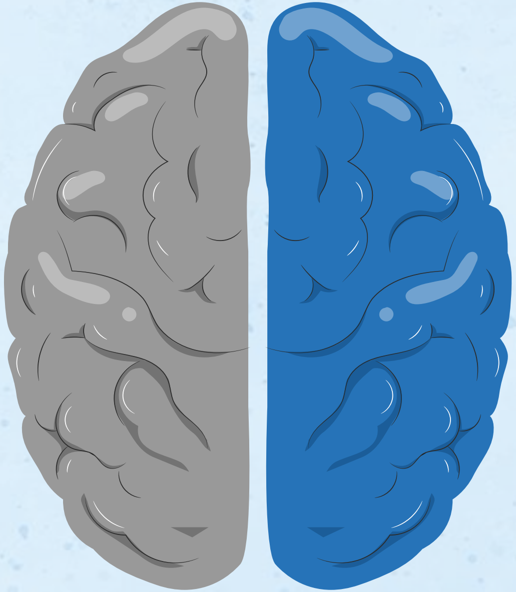
Literature Review

What is the differences between the neural response to winning and losing?

Winning VS Losing

Impact on Emotions

Gambling Task



02

Methode

Segmentation

TR=0.72

Loss Event

8.063	3.5	1
11.688	3.5	1
18.899	3.5	1
26.109	3.5	1
29.708	3.5	1
33.319	3.5	1
95.827	3.5	1
99.439	3.5	1
106.663	3.5	1
113.887	3.5	1
117.485	3.5	1
121.097	3.5	1
146.927	3.5	1
154.164	3.5	1

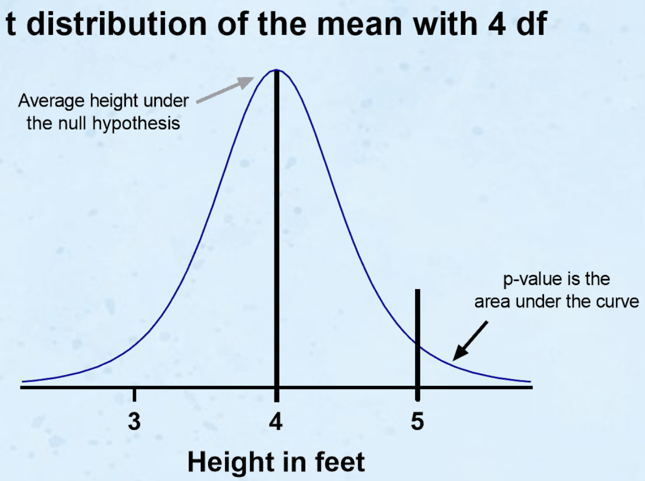
Win Event

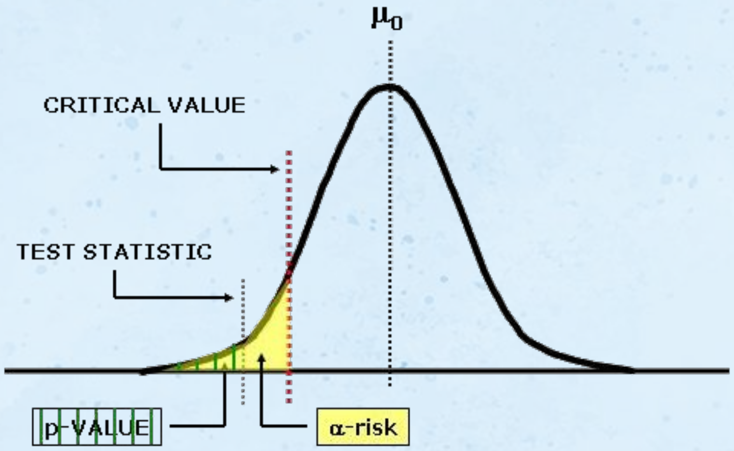
15.3	3.5	1
22.511	3.5	1
51.925	3.5	1
59.149	3.5	1
62.774	3.5	1
66.386	3.5	1
69.998	3.5	1
77.222	3.5	1
103.051	3.5	1
110.275	3.5	1
139.703	3.5	1
143.315	3.5	1
150.552	3.5	1
157.776	3.5	1
161.388	3.5	1
164.986	3.5	1

ROIs

ROI	Abbreviated Form of ROIs	Refrence_atlas_paper_Index
parieto-occipital sulcus	POS1, POS2	(210, 30), (194, 14)
inferior frontal gyrus	44, 45, 47l, a47r, p47r	(253, 73) (254, 74) (255, 75) (256, 76) (350, 170)
middle frontal gyrus	46	(263, 83)
inferior temporal gyrus	TGd, TGv	(310, 130) (151, 171)
hippocampus	H	(299, 119)
intraparietal sulcus	IPS1	(196, 16)
anterior cingulate	a32pr, a24pr, 33pr	(358, 178), (238, 58), (237, 57)
cuneus	V2, V3	(183, 3) (184, 4)
angular gyrus	PGi, PGp, PGs	(329, 169) (322, 142) (330, 150)
orbitofrontal cortex	OFC, 47m, 47s, a10p, p10p, 10d, 10pp, 11l	(272, 92), (245, 65), (273, 93, (268, 88), (349, 169), (251, 71), (269, 89), (270, 90)
posterior cingulate	23d, 31a, 31pd, 31pv	(211, 31), (341, 161), (340, 160), (214, 34)
precuneus	PCV	(206,26)
insula	Ig, MI	(347,167), (288,108)
anterior insula	PI	(357, 177)

Statistical Analysis





The active region between candidates = cuneus

Machine Learning Approaches

Neural Decoding Models:

- Identify brain states using fMRI and ECoG.
- Purposes: Reconstruct stimuli/mental activity & classify stimuli/mental imagery.

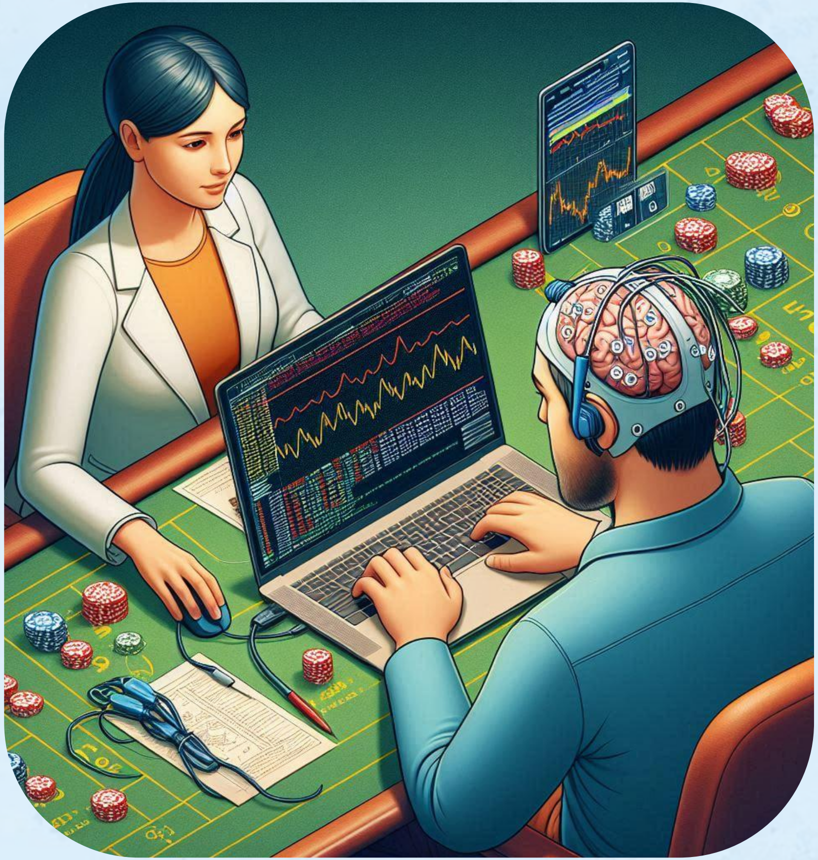
Our Approach:

- fMRI-informed BOLD signal analysis for gambling task outcomes.
- Use LSTM & SVM to predict win/loss states from BOLD signals.
- Trained on data from 90 participants.
- Evaluate accuracy using anterior insula ROI BOLD signals.

- **SVM Hyperparameters:**
  - C: 10
  - kernel: 'rbf'
- **LSTM (Long-Short Term Memory) Architecture**
  - LSTM Layer 1: 128 units, Dropout: 0.3
  - LSTM Layer 2: 64 units, Dropout: 0.3
  - Fully Connected Layer: 1 output unit
  - Activation Function: Sigmoid
  - Learning Rate: 0.001

	Accuracy	F1	Precision	Recall
SVM	0.55	0.39	0.30	0.55
LSTM	0.60	0.59	0.59	0.60

Result for SVM and LSTM

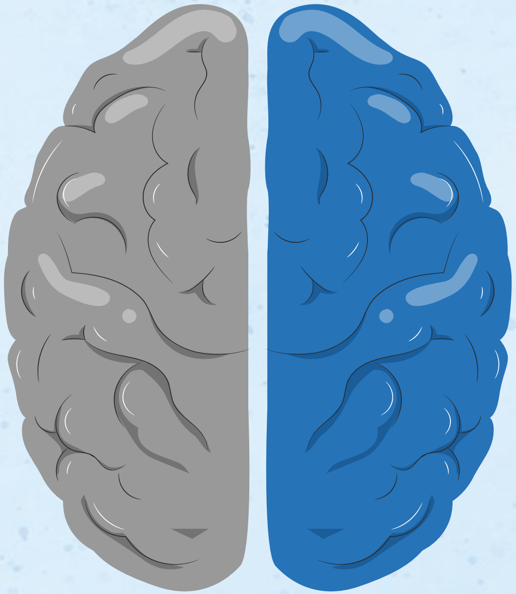


Model Comparison

- **Accuracy**: The LSTM model outperforms the SVM by 5 percentage points. This indicates that the LSTM is generally better at predicting brain states.
- **Precision and Recall**: The LSTM shows higher precision and recall, meaning it is better at both identifying the brain states correctly and minimizing false positives and false negatives compared to SVM.
- **F1-Score**: The LSTM's higher F1-score suggests a better balance between precision and recall compared to the SVM.

Future Directions

- **Hyperparameter Tuning**: Further optimize SVM parameters and LSTM architecture (e.g., more layers, different dropout rates).
- **Feature Engineering**: Explore additional features or different preprocessing methods to improve model performance.
- **Model Comparison**: Test other models or ensemble methods to enhance prediction accuracy and robustness.



03

Conclusion

What we understood?

What our final results tell us?

Martians

Pouya

Bachelor Student
Biomedical Engineering

Mahtab

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Daria

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THANKS!

Do you have any questions?

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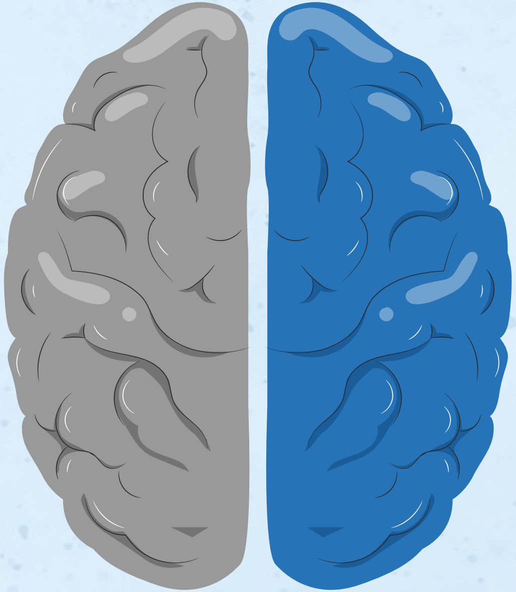

04

References

RESOURCES

Papers

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2. Mahmoudi, A., Takerkart, S., Regragui, F., Boussaoud, D. & Brovelli, A. Multivoxel pattern analysis for FMRI data: A review. *Comput. Math. Methods Med.* **2012**, 961257
3. Daly, I. Neural decoding of music from the EEG. *Sci Rep* **13**, 624 (2023).
4. Sacré, P., Kerr, M. S. D., Subramanian, S., Kahn, K., Gonzalez-Martinez, J., Johnson, M. A., Gale, J. T., & Sarma, S. V. (2016). Winning versus losing during gambling and its neural correlates.
5. Huang, C.-C., Rolls, E. T., Feng, J., & Lin, C.-P. (2021). An extended Human Connectome Project multimodal parcellation atlas of the human cortex and subcortical areas.

Webpages

- Neuromatch Academy
- Tutorials from Neuromatch Academy
- SciPy

Dataset

- Dataset
- Dataset Manual Script
- Sample Dataset

Thank you for your attention