Neural Dynamics of Decision-Making in a Financial Trading Task

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Introduction

- Disposition effect (DE)
- Self winning stocks more often than losing stocks
- Deviation from optimal financial decision-making
- Realization Utility theory
- Pleasure from sale relative to purchase cost (capital gain)
- It hurts to sell at a loss, but “locking in” a gain is satisfying
- When does realization utility emerge during financial choice?
- How do neural signals correlate with individual differences in financial decision-making?

Results: Sensitivity to Capital Gain

- EEG data time-locked to Action period onset
- Subject-level linear regression:
  - Capital Gain: eGain = B1 + β(CapitalGain) + B2(BayesianPosterior) + ε
- Increased gamma activity to loss in High DE group
- Greatest response to smallest capital gain
- Significant for regression on gains only (r = 0.25, p = 0.05)

Results: Sensitivity to Capital Loss

- Early CG response from 150 to 200 ms post-stimulus
- Independent component clustering in EEGlab (N = 58)
- Highest vs. lowest CG quartiles (High vs. Low Gain)
- Medial split on DE (High vs. Low DE)

Conclusions

- Neural correlates of sensitivity to capital gain
  - Localized to vmPFC 400-650 ms after stimulus onset
  - Correlated with propensity to sell winning stocks
- Neural correlates of sensitivity to capital loss
  - Frontal midline sensors 150-200 ms post-stimulus
  - Increased gamma activity to loss in High DE group
- May reflect attentional differences starting from ~100 ms

ERP provides insight into time course of disposition effect
Different neural mechanisms may underlie sensitivity to capital gain and capital loss in financial decision-making

Background

- fMRI correlates of sensitivity to capital gain (CG)
- Ventromedial prefrontal cortex (vmPFC)
- Neural sensitivity to gain correlated with selling “winners”
- ERPs correlate of sensitivity to losses
- Frontal midline theta, gamma activity (4-8, 30-80 Hz)
- Associated with attention, cognitive control
- Predictions: ERP of financial decision-making
  - CG-correlated activity 400-650 ms post-stimulus
  - Localized to vmPFC
  - Correlated with increased tendency to sell gains
  - Early frontal midline sensitivity to loss
  - May reflect individual differences in attention

Methods

- N = 60
- Investing in stock market with stocks A, B, C
- Update period: Price change
- Action period: Buy or sell decision
- Procedure
  - 128-channel EEG
  - Only hold 0 or 1 units of each stock
  - Informed of stock market properties at start of experiment
    - Good state (pup) = 0.7, p(down) = 0.3
    - Bad state (pup) = 0.3, p(down) = 0.7
  - 20% chance of changing from good to bad state or vice versa
  - Payoff after experiment based on stock holdings and sales
  - Distributed source reconstruction in SPM8 (group inversion)
- Linear ordering of CG quartiles
- Localized to vmPFC
- Consistent with FMRi (Frydman et al., 2014)

的行为结果

- 置位效果 (DE)
- 自己赢的股票比输的股票更频繁
- 脱离了最优的金融决策
- 真实的利用理论
- 销售时的快乐与购买时的成本相比较
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- 在金融决策中，当实现的收益和损失时，神经信号如何关联？

配对 t 测试在最优和次优选择，高 vs. 低 DE
- 最优的：赢取和输掉的
- PI 响应（~100 ms）已知可被注意力调节
- 与组间选择的显著差异

时间-频率：赢取 vs. 亏损

- 条件 x 组间交互的theta和gamma范围
- 差异在早期注意力可能影响最优选择

结论

- 神经相关性对资本收益的敏感性
  - 本地化到 vmPFC 400-650 ms 后刺激
  - 与销售赢者相关
- 神经相关性对资本损失的敏感性
  - 前额中线theta (FM)
- CG 最大反应到最小的资本收益
- 线性回归仅对获利变量 (r = 0.25, p = 0.05)

ERP 提供了对处置效应时间序列的洞察
不同的神经机制可能对应于资本收益和资本损失在金融决策中的敏感性。