When Brains are Better Than People: Using fMRI to Predict Markets

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Outline

• The reward-prediction error model of dopamine release
• Applications to decision-making (neuroeconomics)
• Applications to forecasting music sales
• Applications to forecasting market reactions
BELIEFS

WHAT YOU SAY

WHAT YOU DO
Reward-prediction
Reward Prediction Error (TD)

Niv & Schoenbaum, TiCS 2008
Dopamine System

Substantia Nigra

VTA
Dopamine ≠ Pleasure

Dopamine = \Delta \text{ Anticipation}

DECISIONS
Example from Neuroeconomics
Disposition Effect
(with Andrew Brooks)

• People hold onto losses longer than gains
  – Risk-preference
  – Realization Utility
  – Mean Reversion
Disposition Effect

B. No Disposition Effect

C. Disposition Effect
Disposition Effect

Above

Below

\( y = 11 \)

\( y = 2 \)
Disposition Effect
Blunted Response to Upticks

![Graph showing the disposition effect](image)

NO DISPOSITION EFFECT

DISPOSITION EFFECT

Delta Response

Average Integral ($ \times $ Periods)
Disposition Effect Conclusions

• Consistent with mean reversion hypothesis
  – Belief that the asset will revert to mean
  – Those who show DE have expectations met when below the purchase price (blunted response)
Predicting Culture Trends (Music Sales)

**Interest over time**

The number 100 represents the peak search volume

**Search terms**

adele

Add term

Other comparisons

**Limit to**

Web Search

Worldwide
Timeline

- Songs downloaded mySpace.com
- Brain responses collected
- Sales data aggregated

Years:
- 2006
- 2007
- 2008
- 2009
- 2010
Regions that correlate with song likability
Ventral Striatum Correlates with Future Album Sales

![Graph showing correlation between Ventral Striatum activity and future album sales](image)

- **Number of albums sold containing song**
- **Nucleus accumbens activation (beta value)**

Correlation coefficient: \( R = 0.32 \)
Predicting Hits from Brain Activity
Predicting Hits

![Graph showing fraction of songs categorized as hits vs. album sales. The graph compares correct categorization of "non-hits" and "hits." The x-axis represents album sales used to define "hit" status, and the y-axis represents the fraction of songs whose "hit" status was correctly categorized.]
Web-based hit prediction

Goel S et al. PNAS 2010;107:17486-17490
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What Does It Mean?

- NACC and OFC activation markers for both likable songs and future sales
- SEM suggests final common pathway through NACC linking likability to sales
- Possibility of neural focus groups
- Limitations to “hit prediction”
Neuroaccounting
The neuroscience behind the stock market’s reaction to corporate earnings news

work with
Jan Barton and Andrew Brooks
Three questions

• How does the brain react to earnings surprises?

• Is brain reaction associated with stock market reaction?

• How does market aggregate individual brain reactions?
Hypotheses

Ventral Striatum Activity (VS)

Assume: VS = reward-prediction error

(1) $VS_{\text{BEAT}} > VS_{\text{MEET}} > VS_{\text{MISS}}$

(2) RETURN = f(VS)
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1. Long        2. Short

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You are long.

The stock price went up by 6.5%.

You won money.
Stock Return

Earnings Surprise

Stock Return (%)

$R^2 = 0.3493$
$VS_{\text{BEAT}} > VS_{\text{MEET}} > VS_{\text{MISS}}$
Stock Return vs. Striatum

\[ R^2 = 0.3055 \]

![Graph showing the relationship between stock return and ventral striatum activity.](image)
Path Diagram for Total and Mediated Effects

- Earnings Surprise
- Stock Return
- Ventral Striatum

Path coefficients:
- Earnings Surprise to Stock Return: 0.59
- Earnings Surprise to Ventral Striatum: 0.48
- Ventral Striatum to Stock Return: 0.43
- Earnings Surprise to Ventral Striatum: 0.25
Conclusions

• Disposition Effect
  – Belief that the asset will revert to mean
  – Those who show DE have blunted striatum response to upticks (when below purchase price)

• Music Sales
  – Average ventral striatum response to music correlated with future sales

• Neuroaccounting
  – Striatum mediates link between earnings surprise and market reaction
  – Better measure of information?