Predicting Advertising Success: New Insights from Neuroscience and Market Response Modeling

Bryan Bollinger, Hal Hershfield, Masakazu Ishihara, Russ Winer New York University

Vinod Venkatraman, Angelika Dimoka, Paul Pavlou, Khoi Vo, William Hampton Temple University

NYU Stern Center for Measurable Marketing

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Advertising copy testing has a long history

- "Traditional" methods (Lucas and Britt, 1963)
  - Recognition
  - Recall
  - Persuasion
  - Purchase intentions
- These are good at measuring conscious or rational processing

- Non-conscious or emotional responses have been measured by neurophysiological approaches for many years (Stewart, 1984)
    - Pupillary responses
    - Heart rate
    - Eye movements
    - Voice pitch

The era of neuroscience

- Huge growth of research in functional magnetic imaging (fMRI), electroencephalography (EEG), electrocardiography (EKG), and biometrics

- Marketing applications commonly referred to as neuromarketing

- Companies have been established around these methods (e.g.Innerscope)

- Courses being offered

Advertising Research Foundation: Neuro 1.0

- The goal of the project was to "help the (advertising) industry learn how best to apply the capabilities of neuromarketing to real marketing issues and decisions" (Stipp and Woodard, 2011)

- A scientific panel recommended that neuromarketing research should complement and not replace more traditional approaches that have been found to be successful in predicting the performance of advertising on actual sales

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Neuro 2.0

- The ARF sought corporate sponsors to fund research that would link traditional and neuro measures to actual market response

- Only previous study is Berns and Moore (2011) study linking neuro measures to music popularity

- Two teams formed : Temple University and NYU

Basic research question: Are neuro methods "worth it"?

- Two goals: Using commercials and time-series data supplied by 5 companies…

  – Determine the relationships between the neuro measures and traditional measures and between each other

  – See how much variance in market-level advertising elasticities is explained by the individual-level neuro measures

    - Individually
    - Incrementally to traditional measures

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Phase I: Traditional + Neuroscience

- Tested 37 TV ads (all 30s spots)
  - 16 unique brands

- All research conducted in Philadelphia

- Extensive pre-testing of the protocol

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Traditional measures

- 186 subjects completed traditional phase

- Measures for Commercials
  - Liking
  - Familiarity (Commercial)
  - Boring-excitability scale
  - Informativeness Scale
  - Relevancy Scale

- Product Measures
  - Product rating
  - Change in Familiarity (Product)
  - Change in Purchase intent (Product)
  - Change in Usage intent (Product)
  - Change in Recommendation intent (Product)

- Memory Measures
  - Free recall and Aided recall
  - Recognition

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IAT (Implicit Association Test)

- Differences in response latencies (ads vs. foils) are implicit measures of memory (IAT_memory)

- Each image was paired with a positive or negative word

- Differences in response latencies (pos. vs. neg.) are implicit measures of emotional valence toward each ad (IAT_valence)

Eye tracking measures

- 29 respondents did eye tracking and biometrics together

- Measures included:
  - Percentage of valid fixations (total amount of time eyes were focused on the ad)
  - Total fixation count

- Fewer fixations represent more detailed processing

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Biometric measures

- Heart rate accelerations
  - Sympathetic response related to arousal
- Heart rate decelerations
  - Parasympathetic response related to sustained attention
- Heart rate variability
  - Low frequency component (sympathetic)
  - High frequency component (parasympathetic)
- Respiration sinus arrhythmia (RSA)
  - A composite measure of parasympathetic activity looking at synchrony between breathing and heart rate
- Skin conductance: Level and amplitudes (measures arousal)

EEG (Electroencephalography)

- Most commonly used neuro method in ad research

- Companies include Nielsen NeuroFocus

- Reveals variations in electrical signals of cortical brain regions (outer regions)

- Recorded at different frequencies

- EEG provides high temporal resolution but low spatial resolution

fMRI analysis

- 33 subjects participated in this phase

- Measures blood oxygenation during cognitive tasks

- Key parts of the brain: amygdala (affect, emotions), ventromedial prefrontal cortex (vmPFC)(linked to willingness-to-pay), ventral striatum (vSTR)(strongly linked to future purchasing)

- Ads presented in blocks of 8
  - Each ad was followed by three self-report measures: familiarity, liking, purchase intent

Measures Analyzed

Initial list of 46 measures generated from studies

- Fourteen traditional measures

- Three implicit measures

- Seven eye-tracking measures

- Eleven biometric measures

- Three EEG measures

- Eight fMRI measures

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Phase II: Advertising elasticity analysis

Variable reduction

Traditional Measures

Likability

Purchase intent (post-pre)

Recognition

Familiarity

Eye Tracking

Fixations

% Valid fixations

EEG

Composite index

fMRI

Right Amygdala

Left dorsolateral prefrontal cortex

Left ventral striatum

Ventral medial prefrontal cortex

Biometrics

Skin conductance response

Heart rate acceleration

Beats per minute

IAT

IAT Memory

IAT Valence

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Overview of analysis

- Stage 1: Sales response model
  - Estimates the TV advertising elasticities, controlling for other factors that potentially affect sales (or relevant dependent variable)

- Stage 2: Effects of individual-level multi-method measures on TV advertising elasticities
  - Estimates the effects of various multi-method measures on the long-term effectiveness of TV advertising

Data

- Time-series data available from 4 of the 7 sponsors
- GRP data were available at the individual commercial level
- A fifth sponsor provided its own elasticities
- Some executions only ran for a short period of time =>estimated long-term effects only

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Illustrative response function: Firm A (Internet travel services company)

- Weekly Data:
    - DV_s: Market share (S), Recall (R).
    - IV: GRP by creative.

- Model: Seemingly-Unrelated Regression (log-odds for market share & linear for recall)

$$\ln(S_{FirmA,\,t}) - \ln(S_{outside\ option,\,t}) = \alpha_0 + \sum_{j \in B} \alpha_{1j} G_{jt} + \gamma X_t + \epsilon_{1t},$$

$$R_t = \beta_0 + \sum_{j \in B} \beta_{1j} G_{jt} + \delta X_t + \epsilon_{2t},$$

G_{jt} : Ad goodwill for creative j at time t with carry-over rate $\eta = 0.9$.
X_t : Control variables.

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Ad elasticities

Company	Ad	Estimate
A	Ad 1	0.11*
A	Ad 2	0.11**
A	Ad 3	0.16***
A	Ad 4	0.16***
A	Ad 5	0.10
B	Brand 1 Ad 1	-0.01
B	Brand 1 Ad 2	0.09*
B	Brand 2 Ad 1	0.09***
B	Brand 3 Ad 1	0.18***
B	Competitor Brand 1 Ad 1	0.26***
B	Competitor Brand 2 Ad 1	0.09***
B	Competitor Brand 2 Ad 2	0.09***
C	Ad 1	-0.05
C	Ad 2	-0.01
C	Ad 3	0.13**
C	Ad 4	0.41
C	Ad 5	-0.12*
D	Brand 1 Ad 1	0.33*
D	Brand 1 Ad 2	0.12
D	Brand 2 Ad 1	0.17***
D	Brand 2 Ad 2	0.11
E	Ad 1	0.26
E	Ad 2	0.54
E	Ad 3	0.23
E	Ad 4	0.47
E	Ad 5	0.39

Observations on elasticities

- 17/21 positive (ignoring Firm E)

- 12/21 positive and significant

- Mean of the positive elasticities = .14

- Prior analyses and meta-analyses (e.g., Sethuraman et.al. 2011) have found elasticities in this range

Stage 2: Relating methods to elasticities

- In Stage 1, we recovered the long-term effectiveness of advertising for brand i and spot j: ($\beta{\downarrow}ij$).
- In Stage 2, we estimate the effects of various multi-method measures on the effectiveness of TV advertising on sales.
- We model $\beta{\downarrow}ij$ for the tested ads as functions of various multi-method measures from a "reduced space":

$$\beta{\downarrow}ij = f{\uparrow}\beta\,(Firm\ Dummy\ Variables,\ IAT{\downarrow}ijk,fMRI{\downarrow}ijk,ET{\downarrow}ijk,$$
$$EEG{\downarrow}ijk,EKG{\downarrow}ijk,TM{\downarrow}ijk\,) + \varepsilon{\downarrow}\blacksquare ij,\ {\uparrow}\beta$$

where k indexes a measure from each methodology.

- With 26 elasticities and large number of variables, degrees of freedom are a problem.

How much variance in ad elasticities does each method explain separately?

	Model 1 Company dummies	Model 2 Traditional	Model 3 IAT	Model 4 Eye Tracking	Model 5 EEG	Model 6 fMRI	Model 7 Biometrics
Adjusted R^2	.313	.537	.343	.450	.405	.181	.262
% change in adjusted R^2	-	71.6%	9.6%	43.8%	29.4%	-42.2%	-16.3%
F-test p-value	-	.118	.301	.077	.111	.940	.499

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Which neuro method explains the most variance in elasticities beyond traditional methods?

Implicit measures

IAT Memory	**8.01e-4**	**6.42e-4**
IAT Valence	**7.68e-5**	**3.26e-4**

Eye Tracking

# Fixations	**-.011**	**.009**
% Fixation	**-.724**	**2.08**

EEG

Composite Score	**2.59e-4**	**6.30e-4**

fMRI

Amyg	**-.164**	**.253**
dlPFC	**.330**	**.319**
vSTR	**.869**[**]	**.239**
vmPFC	**.400**	**.480**

Biometrics

SCR Amplitude	**.017**	**.078**
HR Deceleration	**2.81e-04**	**.002**
BPM	**-.052**	**.121**

	Implicit	Eye Tracking	EEG	fMRI	Biometrics
Adjusted R^2	.580	.498	.504	.856	.378
% change in adjusted R^2	8.0%	-7.3%	-6.1%	59.4%	-29.6%
F-test p-value	.471	.389	.691	.011	.949

Which neuro method explains the most variance in elasticities beyond traditional methods?

- After controlling for brand dummies and the traditional methods, fMRI is the only (p<.01) significant set of variables => eye tracking and EEG are explaining the same variance in elasticities as the traditional measures

- This suggests that researchers looking for a neuro method beyond traditional pencil-and-paper measures should consider fMRI

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Individual estimates

- The only significant result from the individual neuro equations is a positive impact of the Ventral Striatum (fMRI) ($p < .05$)

- This is similar to the result found in Berns and Moore (2012) and again suggests that activity in this region is associated with rewarding or positive feelings toward a brand

Contributions

- Multi-method protocol using the same stimuli allowing a comparison across traditional and neurophysiological methods

- Examination of the inter-relationships among the measures

- Estimating the relationships between lab measures and actual advertising response (elasticities)

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Conclusions

- Neuroscience methods should not be dismissed as a way to improve our understanding of how advertising works in the marketplace

- Too few ads/degrees of freedom to draw results about the utility of specific methods

- However, interesting result linking individual-level fMRI measure (ventral striatum) to market-level advertising elasticities

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