The Striatum

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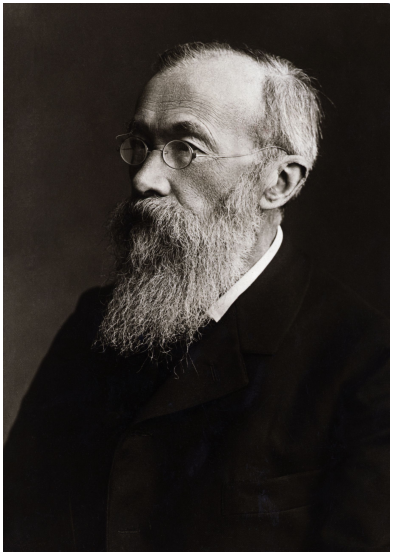
Articles

- Knutson, Brian, Soctt Rick, G. Elliot Wimmer, Drazen Prelec, and George Loewenstein (2007), "Neural Predictors of Purchases", *Neuron*, 53 (1), 147–56.
  - Experiment searching for the locus for the assessment of purchasing decisions.
- Knutson, Brian and Stephanie M. Greer (2008), "Anticipatory Affect: Neural Correlates and Consequences for Choice", *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363 (1511), 3771-86.
  - Anticipatory Affect Model
  - Meta-analysis and review of literature.

On Wundt and Poles of Affect

- Hypothesized several binaries in affect:
  - pleasurable vs. non-pleasurable
  - arousing vs. subduing
  - strain vs. relaxation

"Which central regions are thus affected we do not know. But...the physiological substrata for all elements of our physiological experience, are in all probability to be found in the cerebral cortex..."



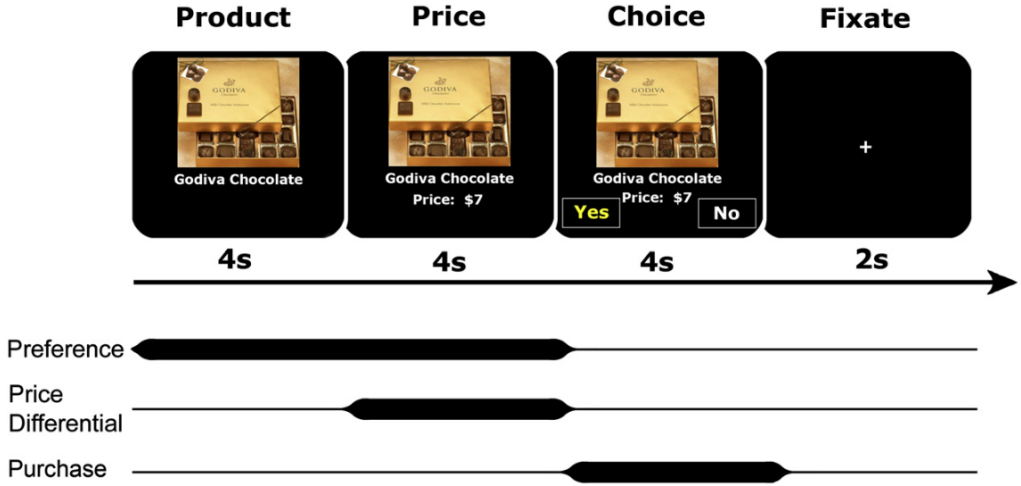
Recent Background (Knutson et al (2007))

- Bechara et al (1996), Kuhnen and Knutson (2005) among others post specific neural regions correlated with positive and negative anticipatory affect.
  - Activations of the Nucleus Accumbens (NAcc) is correlated with positive arousal, while the Mesial Prefrontal Cortex (MPFC) correlates with positive outcomes and prediction errors.
  - Buchel and Dolan (2000) among others propose that the *insula* is correlated with loss anticipation.
- Same correlation holds of behavior with respect to risk:
  - NAcc correlates with risk-seeking behavior...
  - The insula with risk-averse behavior.

Experimental Goal

- Tease out and try to vindicate these earlier findings by:
  - clearly separating experimental stimuli of gain, loss, anticipation and outcome.

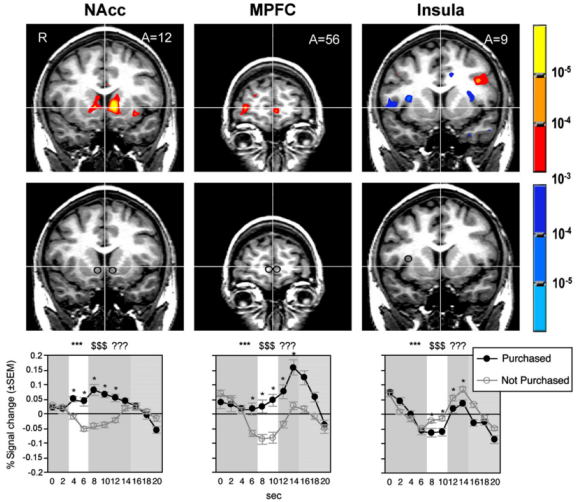
Experiment


Product
Price
Choice
Fixate
Godiva Chocolate
Godiva Chocolate
Price: $7
Godiva Chocolate
Price: $7
Yes
No
+
4s
4s
4s
2s
Preference
Price
Differential
Purchase

Results (basic)

- Product and price periods were marked with substantial activation of the *Nucleus Accumbens*.
- The *Mesial Prefrontal Cortex* (MPFC) was active in the price period, correlated with the price differential.
  - MPFC as mediator?
- When subjects decided to purchase, there was a decrease in activation in the insula.
- Subjects deliberated more when they had weaker preferences.
- No reaction time difference between purchased and unpurchased products.

Topology


NAcc
MPFC
Insula
R
A=12
A=56
A=9
10-5
10-4
10-3
10-4
10-5
*** $$$???
*** $$$???
*** $$$???
Purchased
Not Purchased
%Signal change (±SEM)
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
0 2 4 6 8 10 12 14 16 18 20
sec

But can we *predict* purchasing behavior?

A Logistic Regression

- Will the activation of the NAcc and MPFC predict purchase decisions?
- Several regression analyses show:
  - Self-reported preference predicted purchase.
  - Activation of the NAcc, MPFC and right insula did as well.
  - When a model combines both brain activity and reported preference:
    - Each had independent predictive power
    - **And** brain activity was a *better* predictor of purchasing decisions than reported preference.

Knutson and Greer (2008)

- Arising consensus in the topology of anticipatory affect, but:
  - Are the results really consistent or noise?
  - Can the findings be integrated into a wider theory of cognition and affect with respect to decision-making?

The Affective Circumplex

Anticipatory Affect Model

- Anticipation of outcomes affect *both* arousal and valence.
  - Affective differences aren't neurologically based in independent valence and arousal...
  - Instead they vary in probability of outcome (intensity) and in terms of gains and losses.
- Different from the somatic marker hypothesis in that the AAM...
  - does not posit a feedback loop between the body and brain.
  - Anticipation is inherently "good" or "bad".

Expectations and empirical hypothesis

- Areas of the brain associated with positive and negative arousal should both be active in uncertainty, in a proportion that resembles expected gain or loss.
- Activation of these areas should correlate with reported preference...
- And also actual behavior...

Study compilation

- Search on PubMed for key phrases, looking for studies that differentiated:
  - gain vs. non-gain anticipation
  - loss vs. non-loss anticipation
  - gain vs. non-gain outcome
  - loss vs. non-loss outcome
- Studies that ignored the difference between positive and negative affect were avoided.
- All matching studies were analyzed with an activation likelihood estimate (ALE)

Intended parallel(?)

- Intended parallel with affect circumplex:
  - Positive arousal -> gain anticipation
  - Positive non-arousal -> gain outcome
  - Negative arousal -> loss anticipation
  - Negative non-arousal -> loss outcome
- Are these four priors neurologically?

Results

- Gain anticipation: Nucleus accumbens
- Loss anticipation: Regions of the anterior insula and medial caudate
- Gain outcome: Mesial prefrontal cortex (MPFC)
- Activation was more marked for gains than losses
  - Compare to “losses loom larger than gains” (K&T 1984)

Problems?

- Activation for gains was greater than activation for losses
  - Contradicting the behavioral account popularized by K&T (1984)
  - "Losses loom larger than gains."
- They reject as unverified Tom et al (2007)'s proposition that high levels of activation indicate approach, low levels avoidance.

Is it Cheating?

- (sophomoric questions)
- The article search deliberately eliminated articles that studied "arousal" or "positive valence", etc. *per se*.
  - If we ran a search looking for *these* priors, ignoring the composite "positive/negative arousal" papers, could we find contradictory results?
- Related: There are some regions (the anterior insula, the thalamus, etc.) which are common for particular arousal levels:
  - What keeps us from saying these aren't the loci of an independent sense of arousal?
  - (It's also true of the MPFC and positive valence.)