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**Beyond Behavioral Finance**  
**-The Neuroscience of Investment Behavior**  
Louisville, September 24 2008

## Bullet Points

- Behavioral Finance shows, that in conflict to Modern Financial Theory, we do not always behave rationally.
- Most of our action is governed by the subconscious, by emotions.
- There is no rational behavior without emotions.
- Knowing about emotions can help to control **and employ** them for better investment decisions.

## Failings of modern finance theory

- **Modern finance theory explains the reality of financial markets but insufficiently:**
  - e.g. many players are reluctant to use the benefits of diversification for risk reduction,
  - e.g. trading volume is much higher than could be explained by new information,
  - e.g. actively managed equity funds still dominate,
  - e.g. volatility of stock prices is much higher than could be explained by theory
- **Behavioral Finance - a supplement to modern finance theory, analysis of human behavior for better forecasts, decisions**

## Cognition, valuation, decision Three stages of human action

1. **What is the situation, where are we?**  
To see, perceive, recognize, explain, forecast
2. **What do I want?**  
To evaluate, weight, judge
3. **What has to be done?**  
To decide, take action

**Behavioral Finance shows that there are deficiencies at each of the three stages, often systematic, sometimes avoidable.**

**The three stages describe the logical process. De facto there is strong interaction. E.g. the justification of decisions taken dominates not only the valuation but even the perception.**

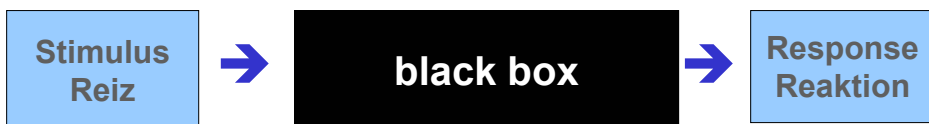
# Behavioral Finance

## Faulty Perception, Evaluation, and Decision

Deficits of Perception	Problems with Decisions
(1) heuristics - mental models	(1) heuristics of decision
(2) delayed perception	(2) preference for status quo
(3) selective perception	(3) splittingeffects
(4) thresholds for perception	(4) accounting-alchemy
(5) overestimation of risks	(5) framing
(6) overconfidence	(6) aversion to regret
	(7) disposition effect
<b>Problems with Valuation</b>	(8) committee decisions
(1) preferences and prejudices	(9) familiarity
(2) thresholds for reaction	
(3) inconsistent risk assessment	
(4) conformism, herding, contagion	

## Behavioral finance - the idea

- Behavioral finance is based on the behavioral psychology of B. F. Skinner (1938).
- According to Skinner it is not possible to know the reasons for human (mis)behavior but luckily also not necessary.
- Each and every behavior has been learned and thus can be unlearned (conditioning).
- Behavioral finance: apparently irrational reactions of investors to certain stimuli - no questions as to causes
- Neuroscience tries to peep into the black box.



## Freud's „Id“, the third humiliation of the human race

- Man had the perception that everything revolves around us. **Copernicus** proved: Not the sun revolves around us but we revolve around the sun. Abruptly we were dislodged from the center of the universe to the periphery.
- As the deputy of God we set out to govern the world until **Charles Darwin** discovered that we are not that special. Just an update of the ape, product of desultory evolution, like all other creatures.
- But one distinction remained for humans: reason, rationality. Then **Freud** revealed that reason is just the flimsy and fragile surface. Below blazes the chaos of instincts, compulsions, and emotions. For Freud this presented the third humiliation of mankind. **Man is not even in command of his own head.**

## Freud's „Id“, the third humiliation of the human race - again accepted reluctantly if at all

- **Copernicus:** The Flat Earth Society still objects: “While the Society is not a "crackpot" group, it is opposed to the fashionable, politically correct Spherical Earth theory, which is expounded every day by so-called "scientists", the media and political leaders. The Society asserts that the Earth is flat and has five sides ...” ( [www.flat-earth.org/society/about.html](http://www.flat-earth.org/society/about.html) )
- 361-year abyss between Galileo's indictment for heresy 1632 and the church's acquittal of him in 1993
- **Darwin:** 137-year gap between Darwin's Origin of Species 1859 and acceptance of evolution by pope John Paul II 1996
- In November of 2003 the Texas State Board of Education approved a list of biology textbooks that scientists believe do justice to Darwin's theory.
- 29 Jan. 2004, “evolution” removed from Georgia schoolbooks
- **Freud:** Discussion in FAZ 2003/2004

## Renaissance of the science of emotion



- Only now Freud's views are attested by Neuroscience
- As keynote speaker drawing the „Decade of the Brain 1990-2000“ to a close, Antonio R. Damasio identified three possible reasons for the long black hole of almost a century between Freud and the new blossoming of the Science of Emotion:

**Sexual fantasies were more attractive to the researchers than analysis of electrochemical processes in the brain.**

**There is “a long philosophical tradition of not trusting emotions, regarding them as unruly phenomena that can wreck havoc on decision-making.”**

**Neuroscience did not have the necessary instruments.**

## Neuroscience used to neglect emotions

- With the traditional tools of neuroscience insights on emotion were hard to obtain.
  - Destruction of brain areas in animal experiment: detect changes in the animal's ability to perceive, learn, control movements. The emotions of animals are difficult to define and to detect.
  - Non-invasive experiments with brain damaged humans: ethical objections and only very few cases (the emotion nuclei are well protected in the center of the brain), difficulties in defining and measuring emotions.
- Rediscovery of the Science of Emotion owed to new chemistry (psychotropic drugs) and new physics (new technical equipment).

## New tools for neuroscience

- After electroenzephalogram (EEG) and computer-tomographe (CT) new imaging techniques: positron-emission-tomographe (PET), magnetic resonance imaging (MRI), and especially functional magnetic resonance imaging (fMRI).
- The scans can not only show which areas of the brain receive fresh, oxygenated blood at any given time, but also the electrical activity when individual neurons fire, chemically discharging e.g. dopamine.
- Current research centers on
  - the strength of neural activities associated with specific perceptions, thoughts, emotions, and activities,
  - the exact areas of the brain where these activities take place.

## Homo sapiens or homo formapetens ? (Jason Zweig)

- Man the pattern-seeker
- Pattern recognition is automatic, unconscious, involuntarily
- Intuitive process centered in the limbic system, the ancient, subcortical part of the brain
- Rapidly jumping to conclusions
- Two is a trend – three a rule

## The nucleus accumbens

- In the hemline of the bridge connecting the two brain sides
- Part of the limbic system, that is in charge of emotions: fury, fear, lust, sexual arousal and aggression (sex and crime)
- The brain nucleus for hope, euphoria but also addiction
- Activated in situations that involve reward and punishment
- Active with calculation of probabilities
- Central in search for analogies, especially left nucleus accumbens lodges patterns even when we positively know that there aren't any.
- Representation of samples and gambler's fallacy, the feeling: "now it is the turn for red"

## Anterior Cingulate Cortex (ACC)

- Although a relatively ancient cortical region, involved with many autonomic functions, the ACC is the main host of spindle neurons.
- Spindle cells appear to play a central role in intelligent behavior and adaptive response to changing conditions and cognitive dissonance (disambiguation between alternatives).
- Found almost only in humans (and great apes and whales).
- Negative surprise more powerful than a positive one
  - 38% of neurons activate when rewards decrease unexpectedly
  - Only 13% activate when rewards increase unexpectedly

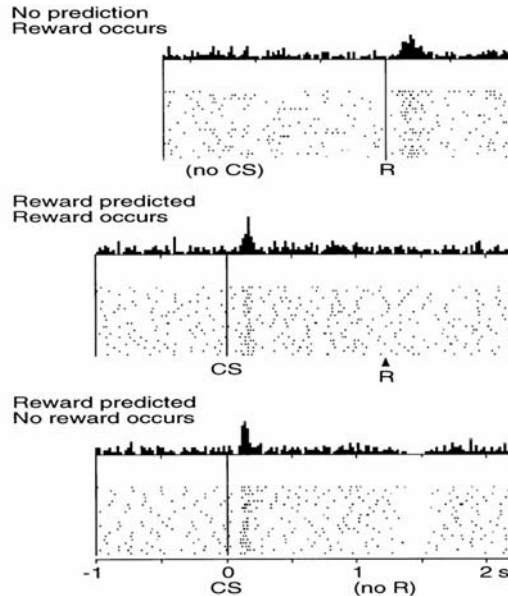
## Forecasting is fun / addicted to forecasting

- Every action is based on forecasts, sometimes explicitly, mostly just implicitly.
- All forecasts are an extrapolation of analogies (trends, patterns, similarities, causations).
- That is why our brain compulsively looks for analogies, causation in random events, order in chaos, it forecasts.
- We always find analogies to base forecasts on, even if we positively know there aren't any.
- ... and proofs (heuristics of availability, selective perception, cognitive dissonance, technical analysis, data mining).

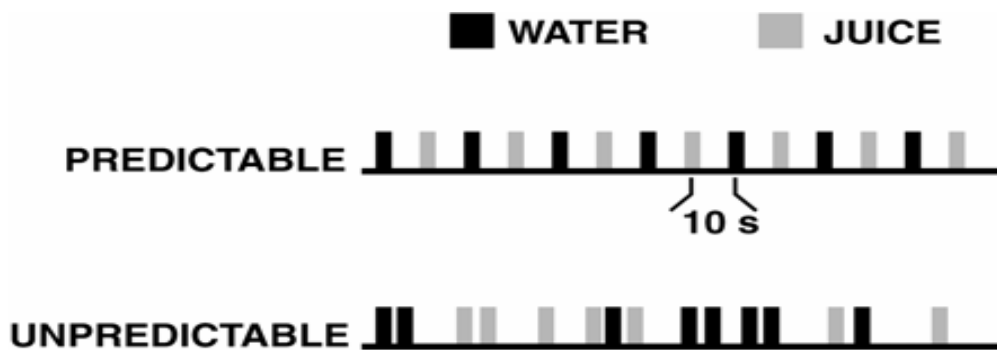
## Happiness is pleasant anticipation and dopamine is the neurotransmitter of happiness

- Neurotransmitter dopamine, most important amplifier in learning activities
- Good vibrations when forecasting
- „The Brain Runs on Fun.“ American saying
- Dopamine causes happiness by pleasant anticipation. However, when we enjoy, relish, parts of the brain are activated that are in charge of conscious perception. And here the neurotransmitter is not dopamine but opioides, drugs produced by the brain that resemble opium.

## Dopamine discharge at the time of the forecast

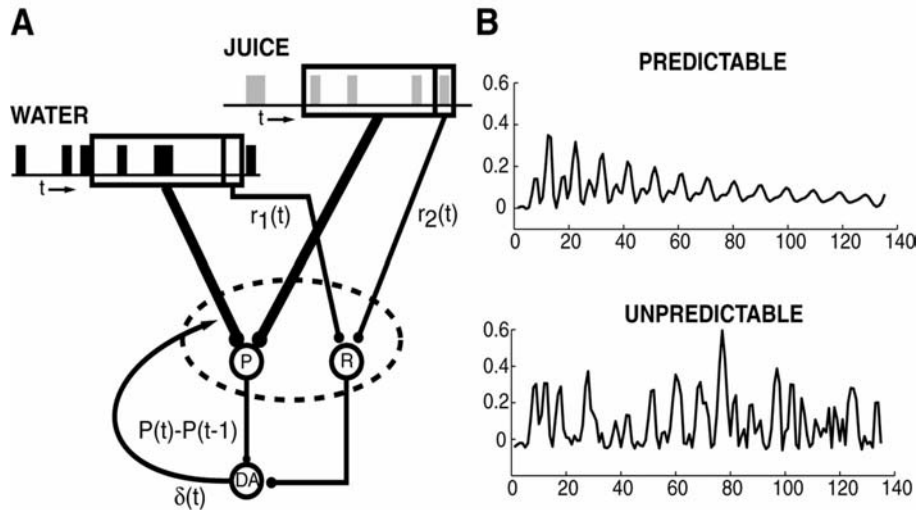


## No risk - no fun / Forecasting is fun



- Dopamin discharge higher when more difficult to forecast.
- People enjoy surprises.

## Juice or water - model of dopamine discharge



## Synthesis of expected return: $2 + 2 = 4$ ?

A synthesis of the **magnitude** and **probability** effects can be performed. It is now clear that the magnitude effect dominates the probability effect for high-value predicted rewards. This synthesis explains lottery behavior: larger potential rewards are more exciting, and this excitement dominates the contrary effect of their low probability. For example, the low probability of payoff from internet stock investments was irrelevant to investors if they imagined that just one of these investments would be spectacularly profitable.

The same is true for risk evaluation

**very high magnitude dominates extremely low probability**  
(Pascal's Gamble).

## High on dopamine, electrified investors

- Our overconfidence is immune to learning. We get our reward now, even if forecasts later turn out to be wrong.
- High stakes trigger dopamine discharge (lottery, penny stocks, IPOs) however small the chances of winning.
- When expected rewards don't materialize, dopamine level and mood go south, a possible reason for the sometimes extreme overreaction when earnings forecasts are just barely missed.
- Does this mean that the investor should suppress his emotions?  
No: but recognize and manage!

## The power of emotions - humiliation?

- Since Freud we know that conscious awareness is only the tip of the iceberg of our intellect, below and much bigger is the subconscious mind.
- Freud felt deeply humiliated by this domination of the "Id".
- Today we recognize our "Id" as an indispensable assistant, who **perceives** things that we fail to see and lets us **act**, without the need for reflection and attention.
- **Perception:** Skin reaction to not recognized acquaintances (Damasio), the 24th picture, furious face
- **Action:** driving, centipede, golf
- But even if we act consciously, reflected, and rational, emotions are of critical importance.

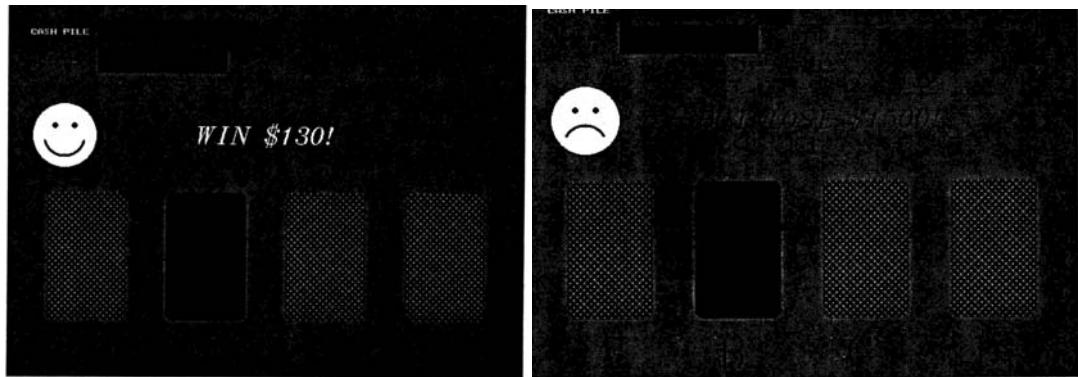
## The error of René Descartes

- Descartes established the credo of rational, cartesian thinking: „Cogito ergo sum.“ or „Je pense donc je suis.“
- His view was: only by thinking man becomes human, rational action must disregard emotion.
- Modern neuroscience begs to differ, and radically so.
- Antonio R. Damasio: **without emotion there is no incentive for rational decision, it just does not happen!** (Descartes' Error, New York 1994)
- Emotions are the engine of thinking.

## Antonio Damasio's Iowa gambling task

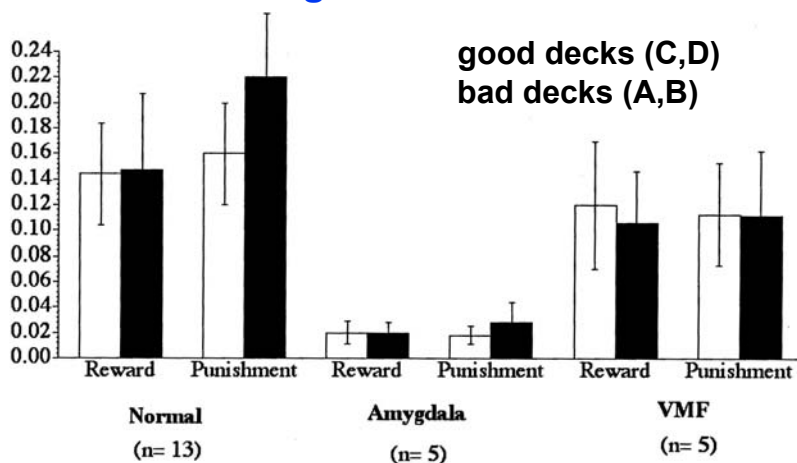
- Patients with **damaged amygdala** can not **generate and therefore feel** the emotion of winning and losing. Without emotional input „rational“ probands just don't care.
- Patients with **damaged ventromedial prefrontal (VMF) cortex** can not **remember and therefore anticipate** the emotion of winning and losing. They develop no long-term winning strategies but gamble on short-term gains.
- The **strength of emotions** is measured by SCR (skin conductivity response), the stronger the emotion, the more humid the skin and the lower the electrical resistance as compared to normal in  $\mu\text{S}/\text{sec}$ .

# The Iowa Gambling Task



- Four stacks of cards to choose from
- A und B bad, possible gain of \$ 130 - maximal loss \$ 1,500
- C und D better, maximal gain lower, much lower maximal loss

## The Iowa Gambling Task: measured emotion after



- $\mu$ S/sec after reward (gain) or punishment (loss)
- SCR (skin conductivity response)

## The somatic-marker-hypothesis

- Antonio Damasio: We make judgements not only by assessing probabilities and consequences, but also, „and primarily“, by evaluating their **emotional** attributes, the somatic marker.
- The „right“ decision is taken only when also **felt** to be „good“.
- **There is no rational behavior without emotion. Without emotion the conscious mind is only a paper tiger, unable to stick to its chosen course.**
- **4Ws: Why do We Want What? All our objectives are based on emotion.**

## „Id“ perceives faster than the conscious mind

- An interesting side outcome of the Iowa gambling task was that the **subconscious perception** of the relative attractiveness of the decks was much faster.
- After **10** drawings normal subjects started to worry when choosing the “bad” decks A or B, skin resistance decreased.
- With **50** drawings players started to voice concerns, that A and B might be “somewhat risky”.
- After **80** drawings most were fully aware of the odds.
- The normal probands then only chose C or D.
- The brain damaged subjects were equally aware of the odds but did not go for a winning strategy. They did not care.

## Conclusion: seven suggestions (not only) for investors

- **Man is not just a thinking machine but at least as much a feeling machine. With no emotion as to the consequences of actions there is no right or wrong.**
- **The act of prediction is addictive. We are hard wired to make forecasts.**
- **A brain that predicts gains looks like a brain that is high on drugs or sex. Suffering illusion of control, pharmacologically addiction prone.**
- **Work your dopamine, you can't possibly fight it.**
- **Seven suggestions**

## 1: Define the right (accessible) objectives

- **Happiness, well-being is not identical to performance. Thrill, fun, status gain are as legitimate. Saving is not always just deferred consumption. Investing in equities, riding the roller coaster of equity markets, can be fun (and thus consumption).**
- **„Hedonic Investment“, motivation and emotion of an investor developing complex investment strategies may be comparable to a sky diver preparing to jump.**
- **Self-commitment, burning the bridges makes use of cognitive dissonance (endowment effect).**
- **Think positively. Happiness by pleasant anticipation of gains, however improbable they may be, nobody can take away again.**
- **But beware of euphoria, the hangover wont take long to come.**

## 1a: Don't worry, be happy - the brain runs on fun

- Good moods, while they last, enhance the ability to think flexibly and with more complexity, thus making it easier to find solutions to problems, whether intellectual or interpersonal. One way to help someone think through a problem, is to tell a joke.
- Laughing, like elation, seems to help people think more broadly and associate more freely, noticing relationships that might have eluded them otherwise - a mental skill important for creativity, recognizing complex relationships, foreseeing the consequences of a decision.
- The intellectual benefits of a good laugh are most striking when a problem demands a creative solution. One study found that people who had just watched a video of television bloopers were better at solving a puzzle used by psychologists to test creativity.

## 1b: Good mood enhances performance, not (only) the other way round

- Andrew Lo et al, 2004
- Online-Traders with more self-control underperform.
- Improving mood the night before explains 24% of the variance of performance of the best third of outperformers.
- Deteriorating mood the night before explains 35% of the variance of performance of the worst third of underperformers.
- Only trade when in the mood!

## 2: Recognize (= perceive and accept) your emotions

- The conscious mind works on 40-60 bits/sec and keeps track of a maximum of 7 objects, that is only a fraction of the processing capacity of the subconscious.
- The „Id“ always perceives faster and always perceives more.
- Be conducive to ideas that are not (yet) based on information to the conscious mind (brainstorming).
- To the „(number-)crunch“ factor add the „hunch“ factor.
- Be conducive to but not just a conduct of ideas from the subconscious. “Id” is trigger happy and tends to decide on scant information (heuristics of availability, anchors, similarities, attention, Antonio’s pizza).
- Bayesian versus frequentist statistics

## 3: Acknowledge the limits to your knowledge

- My main topic is **evaluation** and **decision making**, but first a glance at **perception** and **memory**.
- The amount of information around us is unlimited. A very minor part of it we can apprehend with our senses.
- Of this we perceive only what fits in our (sometimes extremely distorted) model of reality.
- Some of that we remember somehow for some time but in a form that can be severely altered with the next recall.
- (Only) when the memorized item is marked with an emotion it is taken into account for evaluation and decision making.
- Winner-Take-All-Nature of neural signal extraction

## 4: Recognize prejudices - neutralize unfounded urges

- Behavioral finance: investors often act irrationally.
- Neuroscience has some evidence as to why that is so.
- Basis for critical reflection of this behavior applied to perception, valuation, decision, the whole panoply of behavioral finance.
- I could realize, that my preference for BAYER over BASF is due to the fact that I live in Bayer town Wuppertal (home bias).
- I could realize that only the disposition effect lets me stick to my looser shares.
- Gefahr erkannt - Gefahr gebannt or: Un homme averti en vaut deux or: Once burned twice shy?  
(Martin Weber's portfolios, Antonio's pizza, Hans Eberspächer's spittle, amygdala - prefrontal cortex: scant oncoming traffic)
- We have to keep trying. Heisenberg's Unschärferelation applied to emotion: any emotion reflected is not the same any more.

## 5: Nurse your emotional intelligence

- Daniel Goleman 1994
- Be aware of your own emotions.
- emotion management (becalm, comfort, encourage)
  - Dr. Spitzbart's mental hygiene, anchors and selective perception
  - Commitment, self-bondage, burned bridges - amplify the cognitive dissonance, the endowment effect
- Self-motivation, deferred reward - the basis of learning  
Discipline, the marshmallow test
- Recognize your neighbor's emotions (empathy)
- relationship management

## 6: Muster courage for contrarian investments

- **Better performance than dead fish.**
- **You have to deal with maverick risk, the risk of being wrong and alone. And this risk is real. Fund managers who correctly saw the equity bubble, were not in the business any more, when proven right in mid 2000. Although right in the long term, they had been wrong longer than their clients were willing to tolerate.**
- **But it is even worse. As Bob Shiller states in his "Irrational Exuberance", every era, every location has its Zeitgeist. Strong pressure to group conformity is mainly on the subconscious level. Deviating behavior is felt by the other group members as a threat to their reliance on doing the right thing themselves. They don't like that at all. Contrarian investors not only have to consider maverick risk, but also, and mainly, have to fight a very strong subconscious inclination to follow the crowd.**

## 6a: Social exclusion really hurts

### Feeling the Pain of Social Loss

**Poets have long waxed lyrical about the pain of a broken heart. Now, Jaak Panksepp explains, how this metaphor may reflect real events in the mammalian brain. Brain neuroimaging studies reveal that the brain areas that are activated during the distress caused by social exclusion are also those activated during physical pain. Thus, we now have an explanation for the feeling of physical pain that accompanies emotional loss - whether that be the loss of a loved one, rejection by one's social group, or the distress of separation experienced by young animals.**

## 7: Discipline

- **Winning investment bets is fun, but normally takes hard training.**
- **Persistent outperformance on financial markets requires:**
  - **solid proficiency of financial instrument and analytical tools,**
  - **control of illusions as to the reliability of our return forecast (low) and risk evaluations (even worse),**
  - **Discipline, to stay on course when all others sway.**
- **Discipline is rarely fun**
  - **Entertainment value of disciplined strategies no match for exploding tech stocks, penny stocks, gambling**
  - **Discipline by definition means to follow preset rules instead of following the current emotional urges.**

## Literature

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