Neuroscience of trading

Tony Plummer
On the voyage of science we are perpetually sighting great continents of ignorance that we did not even know were there.

Matt Ridley.
Science keeps showing us how little we know. *The Times*. 10th February 2014
Little known facts

1. Brain and body co-evolved
   Brain is large because body is complex
   And *vice versa*

2. ‘Mind’ involves brain *and* body
   Brain is only one part of information-processing system

3. Body’s priority is survival
   Can’t distinguish between real & imagined threats

Body is involved in your decision-making
Another little known fact

1. Learning occurs in three phases
   New information → absorption → application

2. Absorption phase uses energy
   Information moved from long- to short-term memory (Donald Hebb)

3. Energy diverted from other activities
   External rest / internal work

NOT the ‘S’-shaped learning curve
‘S’-shaped learning curve

- Slow start
- Rapid progress
- Ceiling
Learning is a three-stage process (Henry Mills):

1. Fast start
2. Relapse
3. Application of learning

Learning transferred from short-term memory to long-term memory.
Daniel Kahneman’s Prospect Theory

1. Endowment effect
   Owning something increases its value to you

2. Loss aversion
   Losses have a greater psychological impact than gains

3. Reference point
   Subjective *earlier* state used to evaluate gains and losses

Traders cut profits and run losses
What’s going on?

1. Prospect Theory identifies subjective biases
   Contradicts ‘rational’ (left-brain) behaviour

2. Sense of self comes not just from body
   Includes ‘internal objects’ signifying attachments

3. Need to protect ‘self’ creates anxiety
   Financial losses affect bottom line and sense of self

Actual and potential losses create anxiety
Financial market losses

1. *Possibility* of increased loss outweighs *probability* of increased loss

2. Have to reduce possibility to zero

No comparable mechanism for profits
The DJIA, 2007-09

Volumes rise as bear evolves

DJ Industrial Average
(Weekly; Heikin-Ashi)
Data source: Bloomberg
Fear & anxiety

1. Imagined threats same as actual threats
   Brain cannot tell the difference

2. Fear & anxiety have a physical dimension
   Flight/flight/freeze

3. Amygdala(e)
   Overrides rational thought

Need to understand role of amygdala
Human brain

1. Brain stem
   Reptilian ancestry

2. Limbic system
   Mammalian ancestry

3. Neo-cortex
   Distinctively human

‘Triune’ brain (Paul Maclean)
The triune brain: brain stem

- Reptilian ancestry
- Instinctive behaviour
- Biological drives
- Compulsive behaviour

Brain stem
The triune brain: limbic system

Mammalian ancestry
Emotions
Long-term memory
Group behaviour
The triune brain: neo-cortex

- Neo-cortex
- Frontal cortex
- Pre-frontal cortex

Human

- Focused attention
- Motivation
- Monitoring of goals
- Regulate emotions
- Abstract thinking
- Recreation of past
- Anticipation of future

Suppress neo-cortex → brain stem & limbic system
The amygdala

Deals with change
Stores memories of emotional events
Matches patterns
Triggers learnt reactions
Surprise!

• Electrical ‘spike’
• Activates visual system
• Focuses attention
• Orientation response
Surprise!

Rational thought is short-circuited

Amygdala alarm

Physical readiness for fight or flight or freeze

Conscious awareness
Thinking slow and acting fast

In case of need to anticipate outcomes

In case of danger

500 milliseconds

30 milliseconds

Stimulus

Occipital lobe & Pons

Thalamus

AMYGDALA

Activated?

Status quo

Brain stem

Hypothalamus

FEAR RESPONSE

Thinking slow and acting fast

Amygdala over-rides rational behaviour
Fear response

Brain stem
- Autonomic nervous system
- Sympathetic nervous system
  - ‘Fight/flight/freeze’
  - Pupils dilate
  - Respiration increases
  - Heart rate rises
  - Digestion inhibited
  - Saliva inhibited

Hypothalamus
- Endocrine system
- Hormones
  - Adrenaline (prepare for action)
  - Testosterone (promotes aggression)
  - Cortisol (minimises unnecessary energy use)
  - Endorphins (reduces pain)
  - Oxytocin (promotes attachment)

Body is involved in decision-making
Fight-Flight-Freeze

**Orientation response**

- **Mobilisation**
  - Sympathetic nervous system

  - **Bigger losses?**
    - **Yes**: **Status quo**
    - **No**: **React?**

  - **React?**
    - **Yes**: **Ready?**
      - **Yes**: **Fight**
      - **No**: **Freeze**
    - **No**: **Freeze**

  - **Mobilisation**
    - **Flight**
      - **Follow crowd**
        - **Rest & digest**
          - Para-sympathetic nervous system

- **PRICE FALL**
  - **Fight**
    - **Objective buy/sell rules**

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Fight-Flight-Freeze

PRICE FALL

Orientation response

Bigger losses?

Y

Mobilisation
Sympathetic nervous system

React?

N

Focused attention
+ Heightened state of fear = TRANCE-LIKE STATE

CORTISOL

Freeze
The big freeze

1. Resist taking losses
   Impact of every price change progressively magnified

2. Cortisol
   Prepares body for survival

3. Trance-like state
   Open to suggestion

‘Loser’ effect
‘Loser’ effect

1. Survival mode
   Interruptions to: digestion, sleep, immune system, sex

2. Prolonged & severe stress
   Blood pressure; raised cholesterol; high glucose
   Increased weight; heart attack; diabetes

3. Widespread impact
   Long-only funds cannot avoid bear
   Governments cannot stop it

Cortisol dominates a bear (John Coates)
What about a bull trend?

- Orientation response
- Cash to invest?
  - Y: Mobilisation (Sympathetic nervous system)
  - N: Status quo
    - N: React?
      - N: 
      - Y: Buy (Follow crowd)
    - Y: Buy (Follow crowd)

What triggers a ‘buy’ reaction?
Individual exuberance

1. Learnt beliefs about trend
   After 38.2% retracement of previous trend

2. Testosterone
   Slow-acting; improves performance
   Feedback loop with prices

3. Dopamine
   Pleasure and anticipation of pleasure

‘Winner effect’
**Winner effect**

1. **Testosterone for competition**  
   10 times more in men than women  
   Women less prone to ‘winner effect’

2. **Testosterone increases risk appetite**  
   Stabilises attention  
   Increases reaction speed

3. **Feedback loop with success**

Testosterone dominates bull (John Coates)
Two lines of enquiry

- Technical Analysis
  - Individual Investor: Can we avoid stress and over-exuberance?
  - Anticipating the Market: How is individual experience related to collective order?
Neutralising Prospect Theory

1. Endowment effect
Owning something increases its value to you

2. Loss aversion
Losses have a greater weighting than gains

3. Reference point
Need earlier state to evaluate gains and losses

Defining the problem reveals the solution
Decisions that are right for you

1. WAIT before you change anything
   Hope and despair trigger different reactions

2. Stress/exuberance is information
   Physical reaction is relevant

3. Don’t ignore intuition
   Your body knows more than you think you know

The mind depends on the body
Neuro-science of groups

1. We don’t know everything
   (Certainty is not the same as perfect information!)

2. Rely on others for missing information
   Over-rides personal information

3. Awareness of others’ behaviour
   Rational observation
   Non-rational sensing

   Basis of ‘herding’ or ‘swarming’
Herding

1. Psychological
   Brain wired for social co-operation/cohesion
   Right brain/feelings

2. Imitation
   Mirror neurons
   Others’ facial expressions, posture, tone of voice, movement, etc

3. Emotional contagion
   Information influenced by feelings
   Steroid hormones ensure that we all have the *same* feelings

*Non-rational* groups
Non-rational groups

Five principles

Self-organising
- Purposeful
- Persist through time

Super-organism
- Parts expendable

Shared beliefs
- Act as glue
- Accepted uncritically
- Contagious

Neural network
- Group mind
- Individuals as ‘nodes’

Inter-group competition
- Pecking order
- Competition
- Warfare

Us vs Them
Us vs Them

1. Group psychology controls:
   Nation states
   Armies
   Religious sects
   Political parties
   Football crowds
   Gangs
Us vs Them

1. Group psychology controls:
   **Stock markets**
   Bulls vs bears

2. Groups will follow a leader
   Reflects group beliefs

3. Price trends reflect stock market beliefs

Leadership provided by price movements
Model of mass behaviour

Learning occurs in three-waves

38.2% of bear
38.2% of bull

LEARNING
LEARNING
TRANSITION
TRANSITION
LEARNT
LEARNT
Neuro-model of mass mind

Actual pattern varies depending on bigger cycle
The threefold sequence of change

Forcible separation from old
Creative introduction of new
Natural selection

Elliott and Gann treated sequence differently
‘Elliott’ interpretation

Elliott’s 5-3 pattern is sign of evolution
Gann’s interpretation

Each cycle has evolution-specific pattern

Energy gap in base cycle

Energy gap in whole process

Transition Base

Innovation Trend

Consolidation Correction
Ordered behaviour in the DJIA

Average of three 35-year cycles

6-month % change

Percent of cycle time elapsed

Gap?

32 years

35 years

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Gann’s mass pressure pattern

Absolute level

Momentum

SHOCK
Does it work?

54-year Kondratyev cycle in US wholesale prices

Rapidly rising money supply + WAR

GAP
7 years of ‘preparation’

WE ARE HERE!

1785
1840
1894
1949
2002

1792
1847
1901
1953
2009

1840
1894
1949
2002
2057

Percent of cycle time elapsed

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1. Economy and markets are non-random
   ‘Randomness’ is very short-term

2. Driven by collective dynamics
   \textit{Physical} effect of steroid hormones
   \textit{Individual} psychology interacts with \textit{group} neural network

3. Traders need to be \textit{independent} of crowd
   Personalised approach
   Aware of your limitations

   Technical Analysis
Practical source reading

1. *Thinking Fast and Slow*
   Daniel Kahneman

2. *The Hour Between Dog and Wolf*
   John Coates

3. *Global Mind*
   Howard Bloom

4. *The Law of Vibration*
   Tony Plummer

Implications for your decision-making process