Neuroeconomics :

Neuroscience of decision making

Lecture N5

Affective mechanisms of decision making

Vasily Klucharev

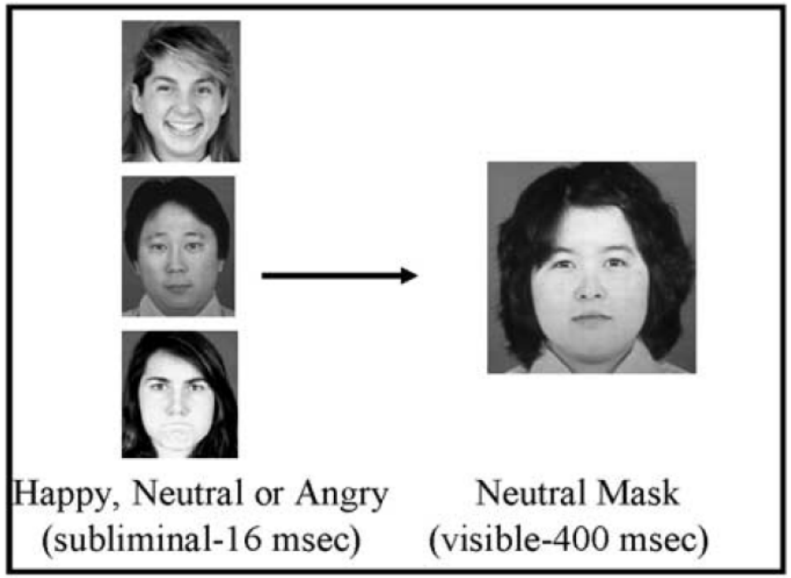
- Higher School of Economics

Figure 1. Illustration of the technique used to contract the different facial muscles: left, lips condition; right, teeth condition.

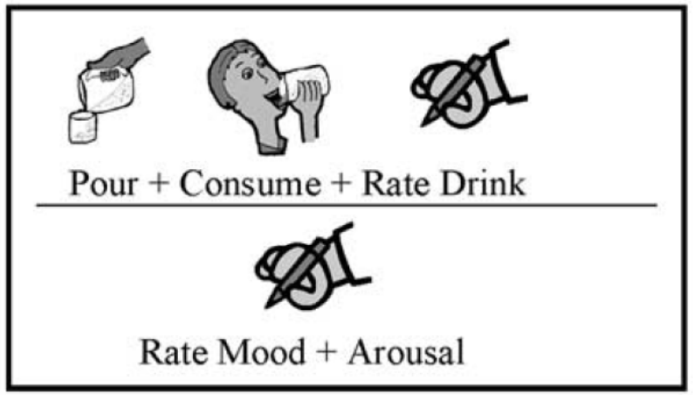
Table 1
Ratings of Funniness and Difficulty: Study 1

	Position of pen		
Cartoon	Lip	Hand	Teeth
First	3.90	5.13	5.09
Second	4.00	4.10	4.19
Third	4.47	4.67	5.78
Fourth	4.90	5.17	5.50
Mean funniness	4.32	4.77	5.14

Strack, Martin, and Stepper (1988)



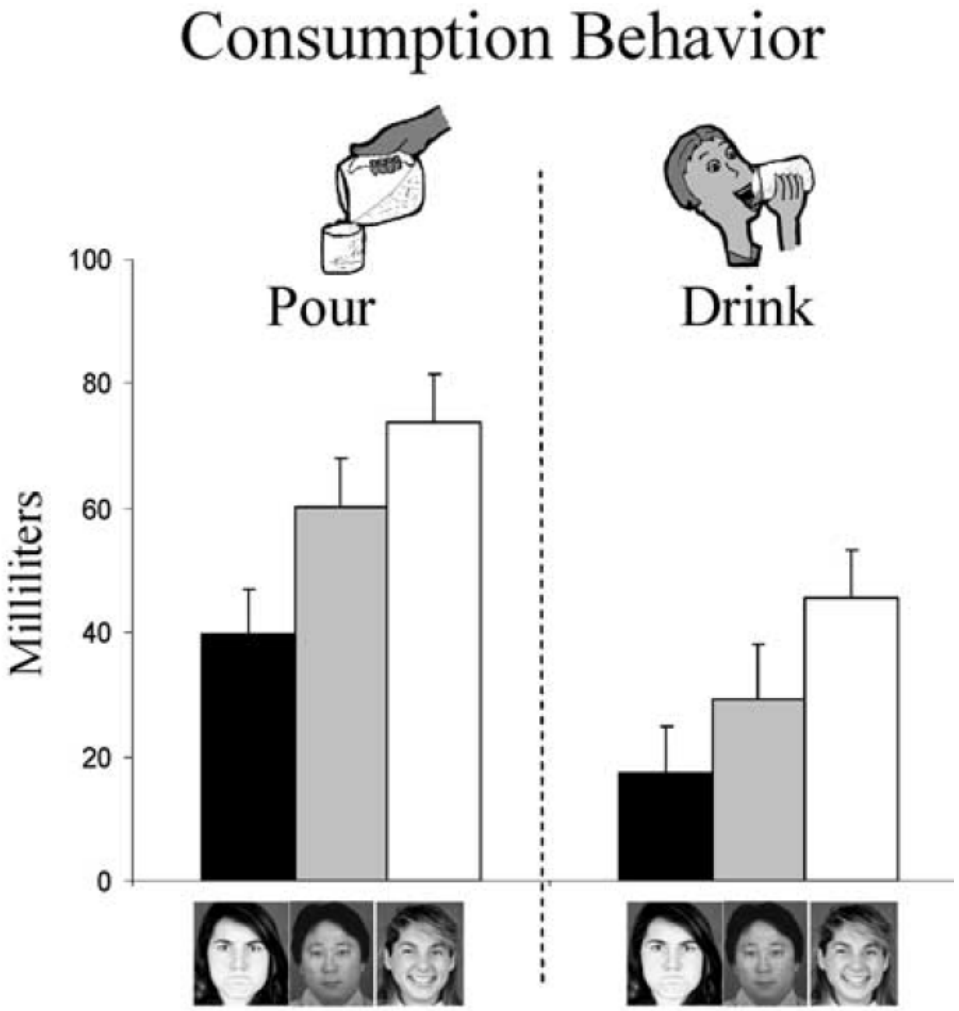
Gender Classification Task (8 trials)



Drink and Mood Task (counterbalanced)

Unconscious Affective Reactions to Masked Happy Versus Angry Faces Influence Consumption Behavior and Judgments of Value

Piotr Winkielman
University of California–San Diego
Kent C. Berridge
University of Michigan
Julia L. Wilbarger
University of Wisconsin–Madison



Winkielman et al. 2005

Temporal discounting

Chose between a smaller sum tomorrow (range over the 18 choices: $15 to $35), or a larger sum (range: $50 to $75) after
a specified delay (range: 7 to 236 days).

k – individual discount parameter

THE ROYAL SOCIETY biology letters

Do pretty women inspire men to discount the future?

Margo Wilson* and Martin Daly

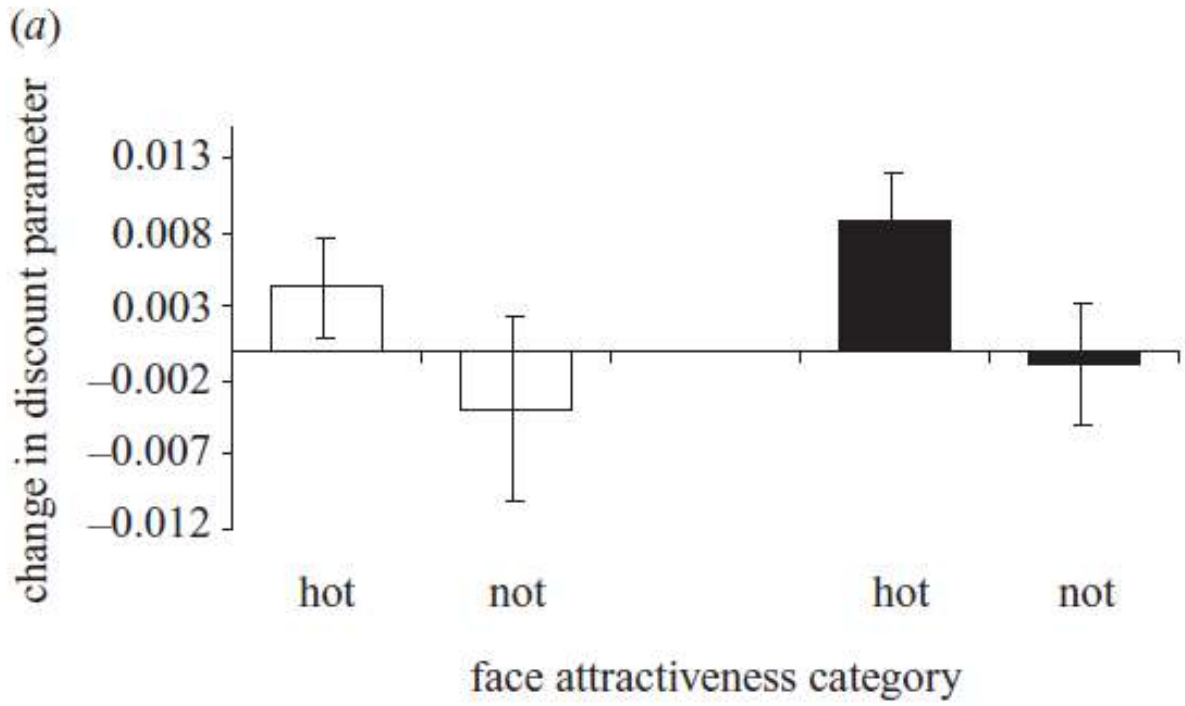


Figure 1. Change in hyperbolic discount parameter *k* after an image rating taskafter rating photographs of opposite-sex faces

Females Males

The relationship between whether a day is sunny and stock returns that day

26 stock exchanges (1982 – 1997)

- Sunshine is highly significantly correlated with daily stock returns. After controlling for sunshine, other weather conditions such as rain and snow are unrelated to returns.

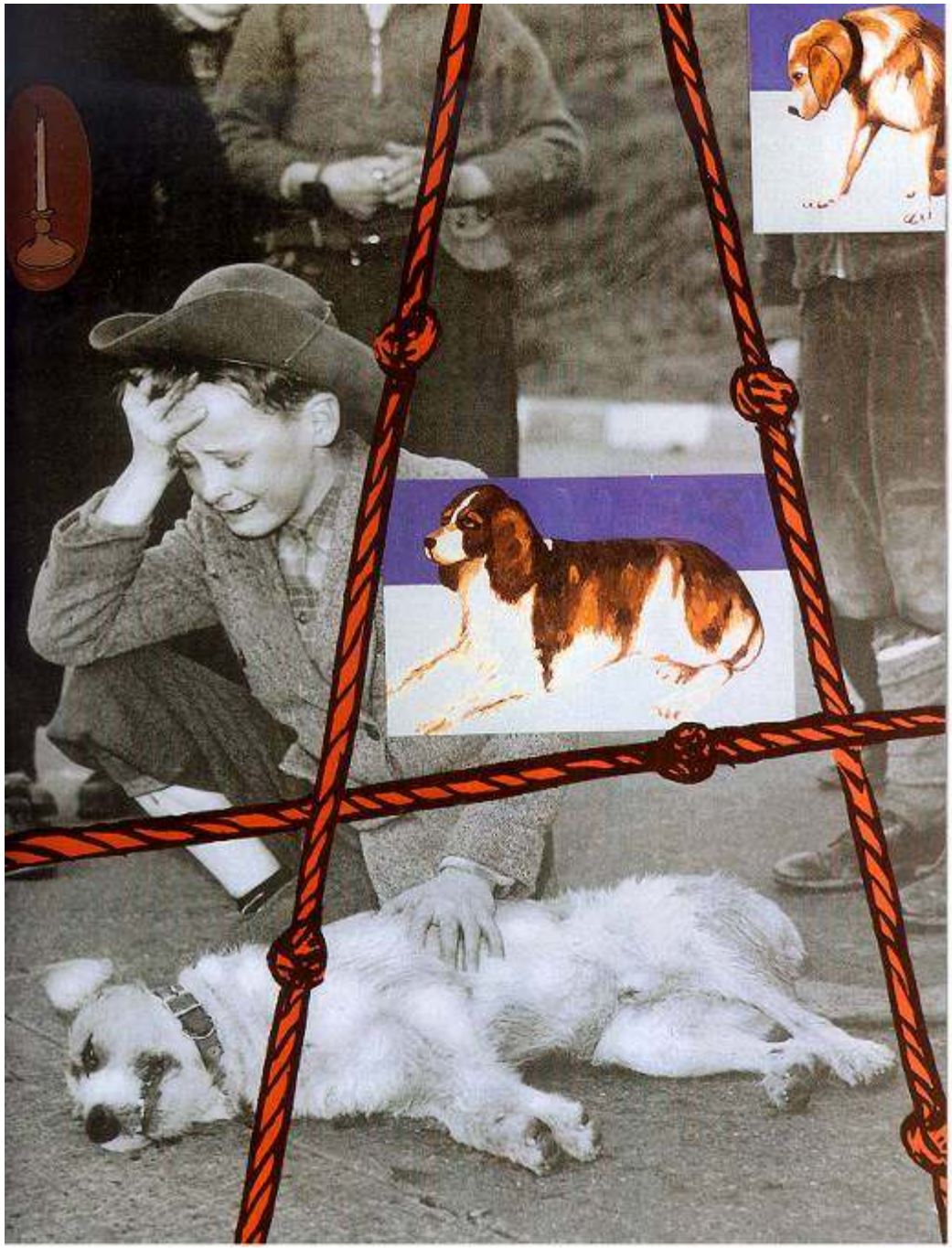
THE JOURNAL OF FINANCE • VOL. LVIII, NO. 3 • JUNE 2003

Good Day Sunshine: Stock Returns and the Weather

DAVID HIRSHLEIFER and TYLER SHUMWAY*

Sam and Our Dog Tom, Brooklyn, New York, 1994. *and you want the world to be your son in his house in his bathtub with his dog*

Eugene Richards

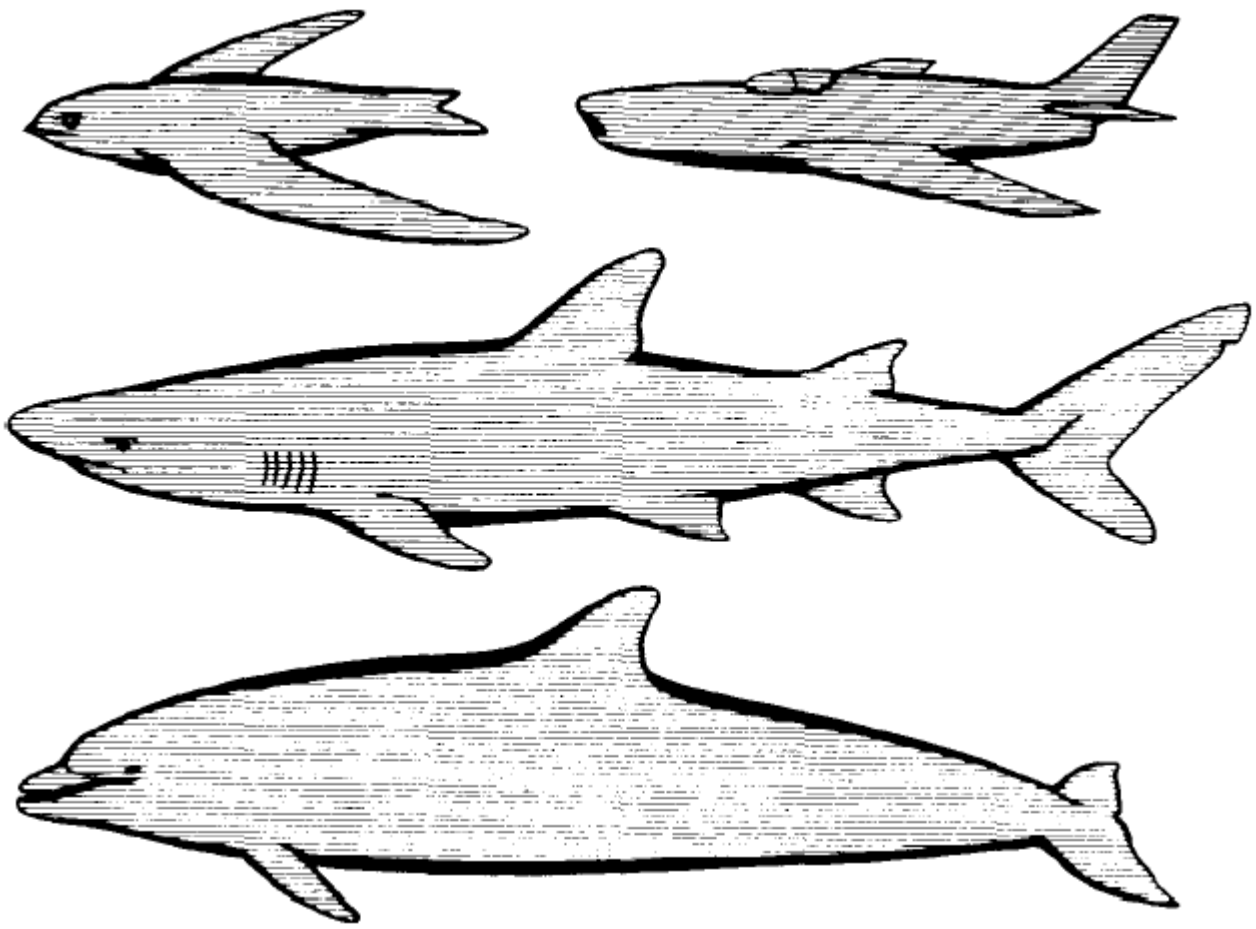


Role of Emotions in Decision-making!?

Some emotional stimuli have innate values

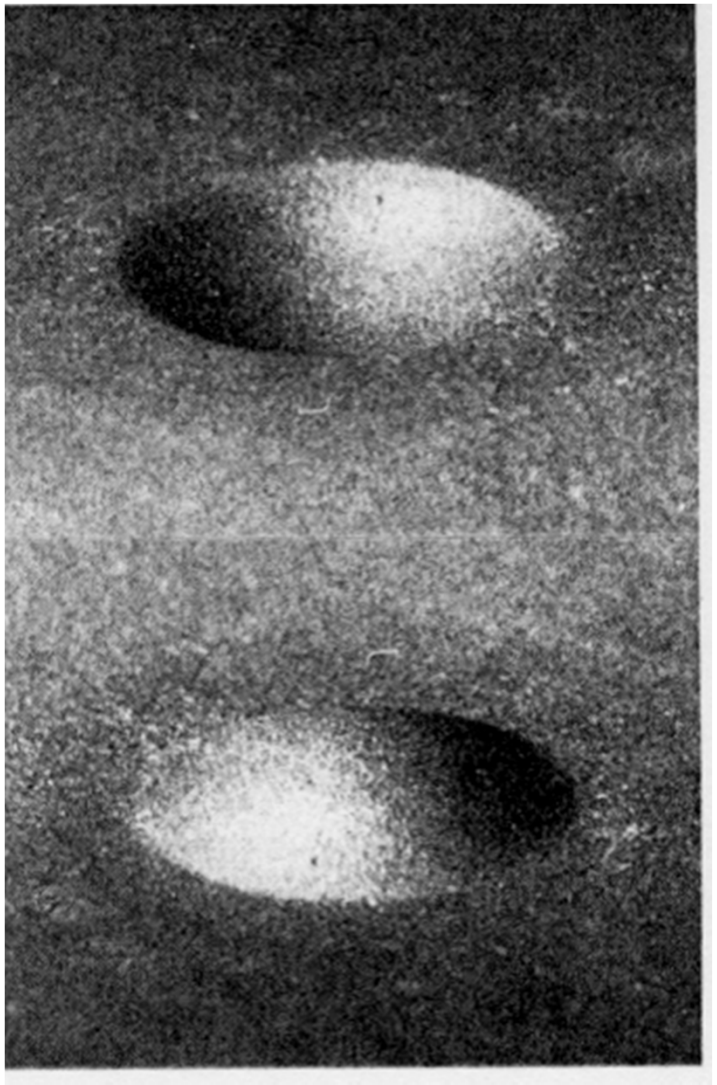
”Our cognitive and perceptual categories, given to us prior the individual experience, are adapted to the environment for the same reason that the horse’s hoof is suited for plains before the house is born, and the fin of a fish is adopted for water before the fish hatches from its egg”

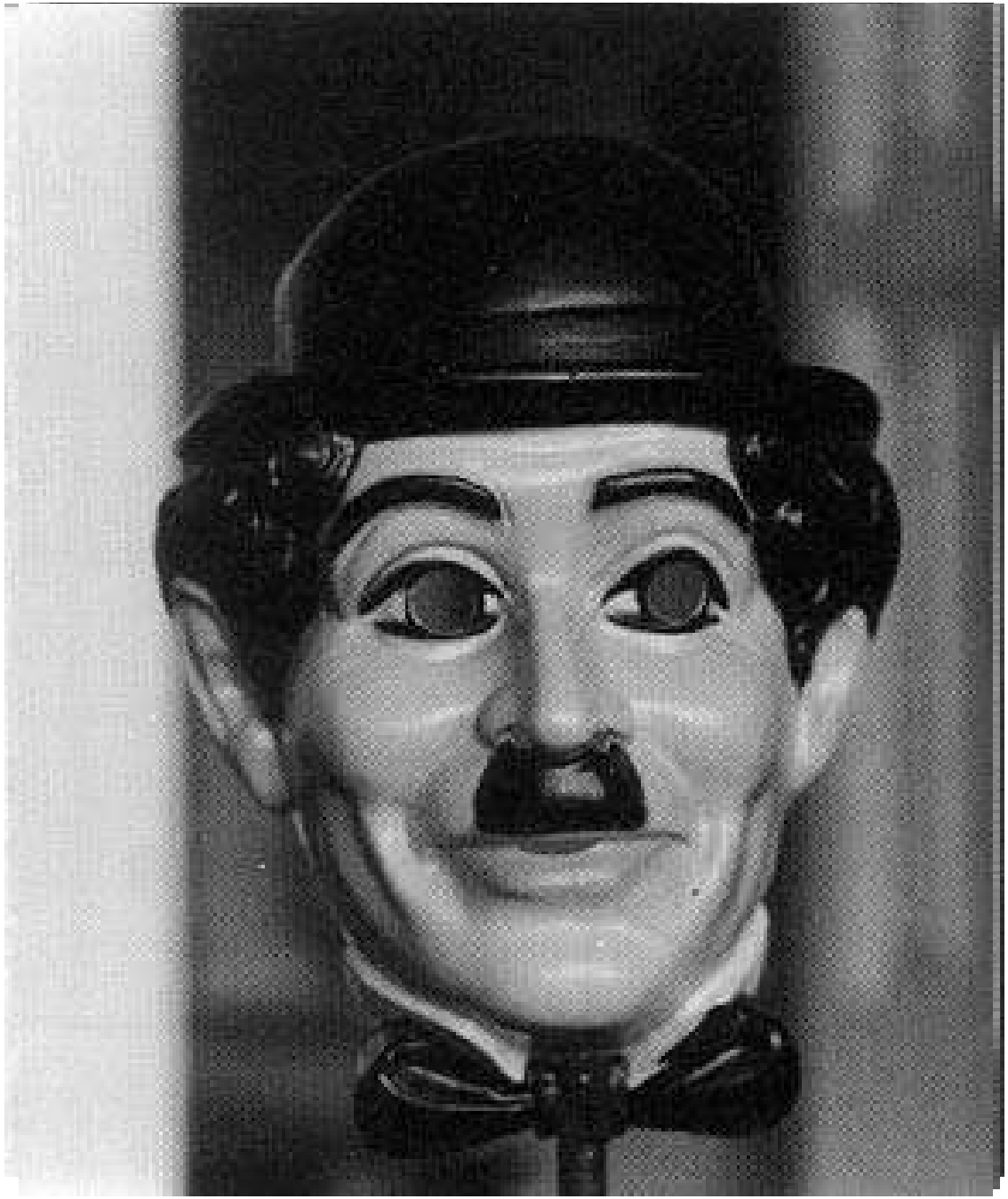
K.Lorenz, 1941



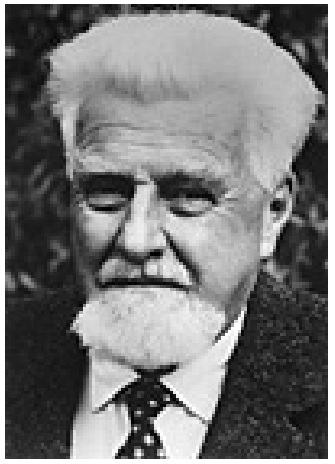
Konrad Lorenz Nobel Lecture

Evolutionary adaptation in perception: innate recognition.





- A particular behavior in Lorenz-Tinbergen concept is not stimulated by external stimuli, but released by them.
- Usually a behavior is blocked till particular stimulus is presented.
- **”Innate releasing mechanisms”** – specific data processing mechanisms that act as a stimuli filter - specific behaviors are elicited (released) by specific stimuli.

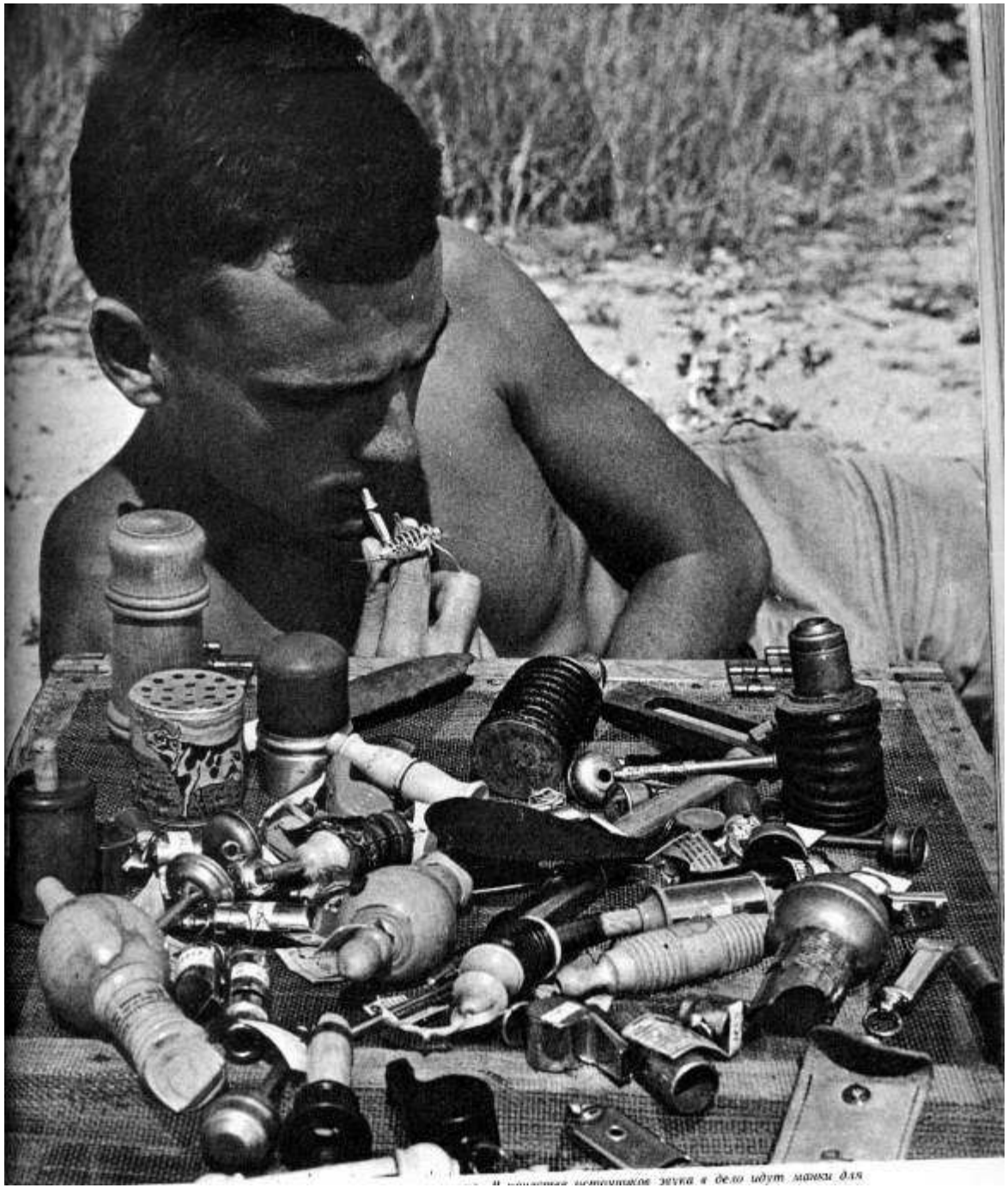


Konrad Lorenz

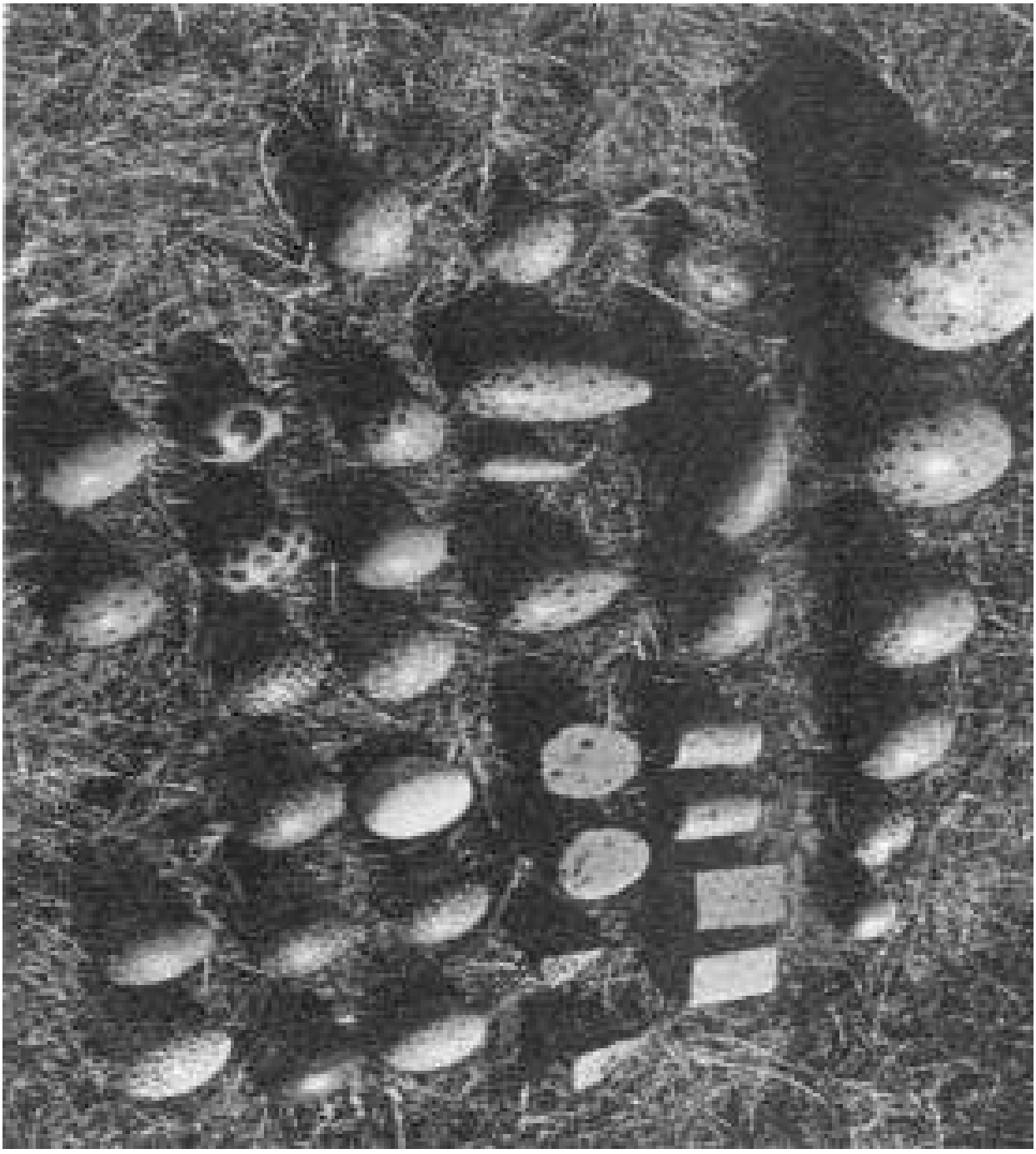
Nikolaas Tinbergen

”Innate releasing mechanisms” – specific data processing mechanisms that act as a stimuli filter - specific behaviors are elicited (released) by specific stimuli

Many of the emotional (e.g. emotional expressions) stimuli are releasers!



...и вместо источников звука в дело идут маски для



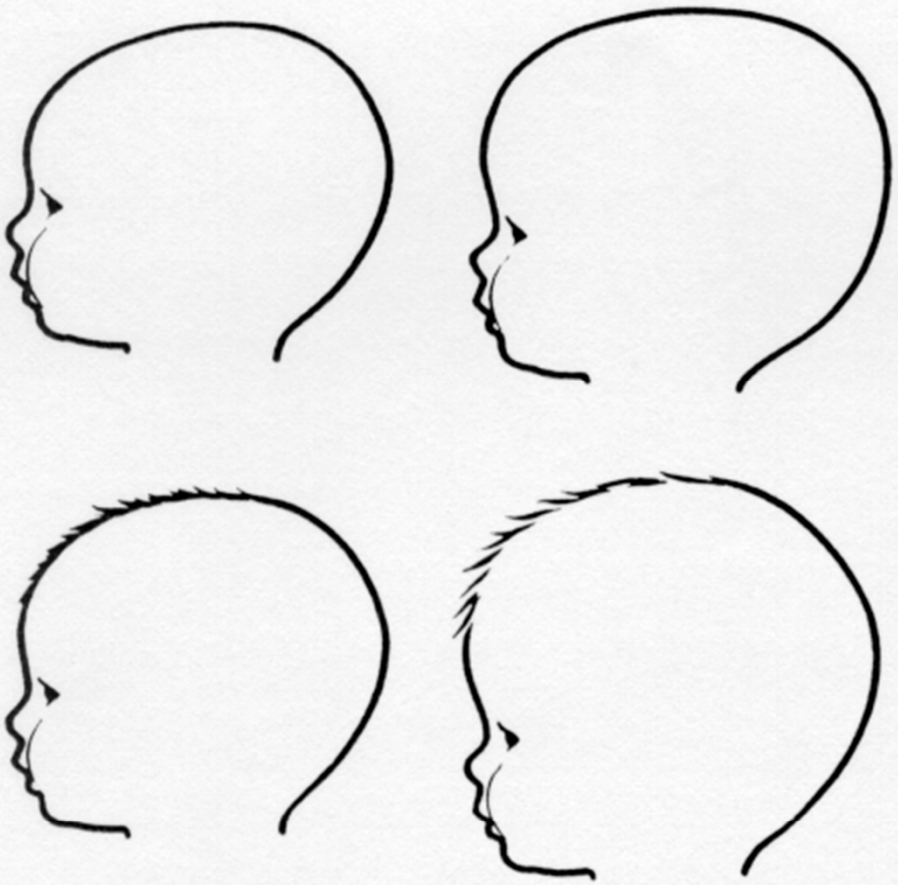
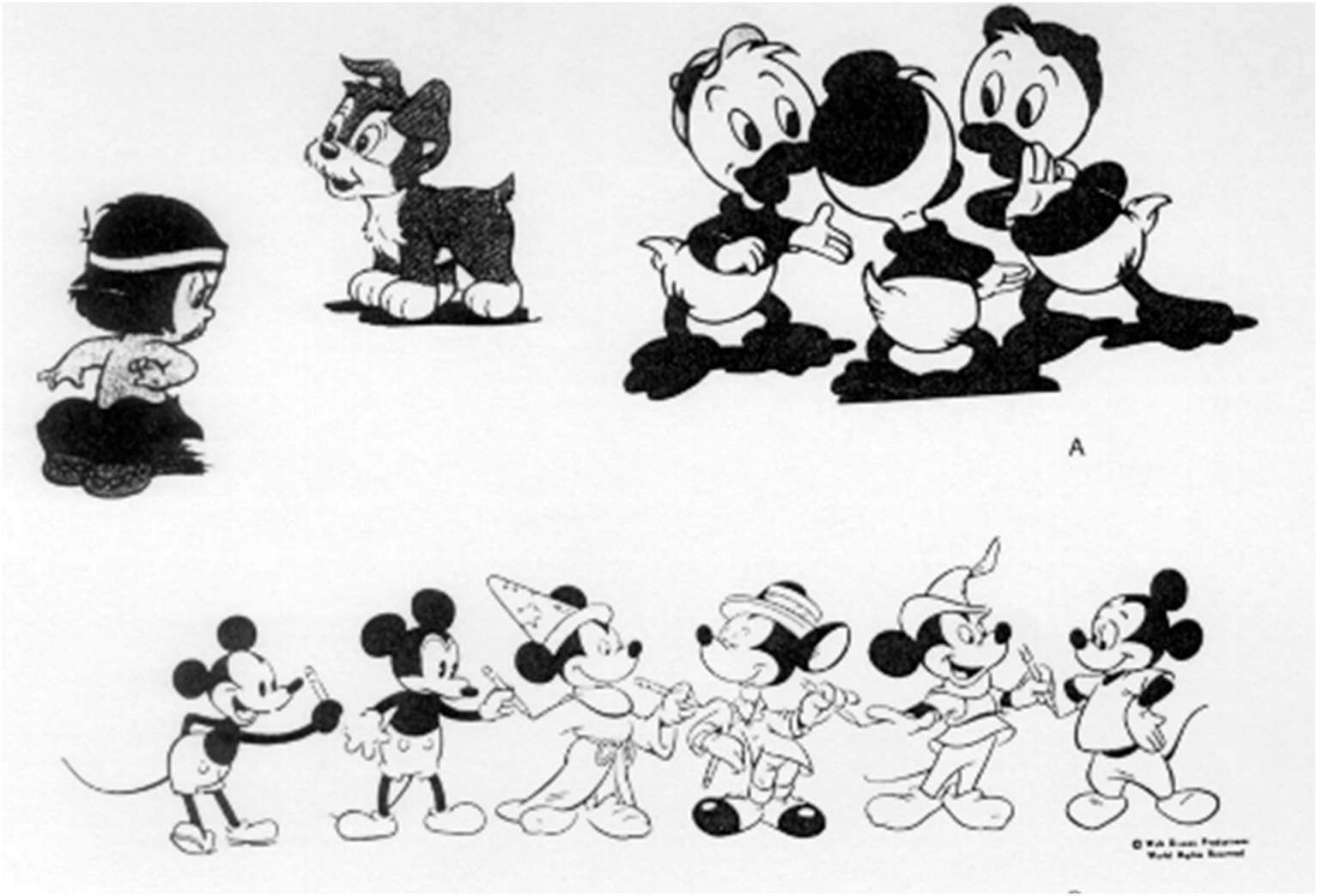


FIGURE 2.42. Infant schema. *Top:* head with normal shape (left) and exaggerated shape (right). The latter drawing was preferred by 10- to 13-year-old girls and 18- to 21-year-old boys. *Bottom:* modifications of the frontal bone curvature (left) and the upper head height (right) in B. Hückstedt's study. Isolated exaggeration of both characteristics resulted in preference for the mean (but not maximum) proportional exaggeration. From B. Hückstedt (1965).

E. Eibl-Eibesfeldt, 1989

Biological level of pleasant stimuli perception



E. Eibl-Eibesfeldt, 1989

The theory of basic emotions

- All cultures identify the same kind of emotions: anger, disgust, fear, sadness, joy and surprise.

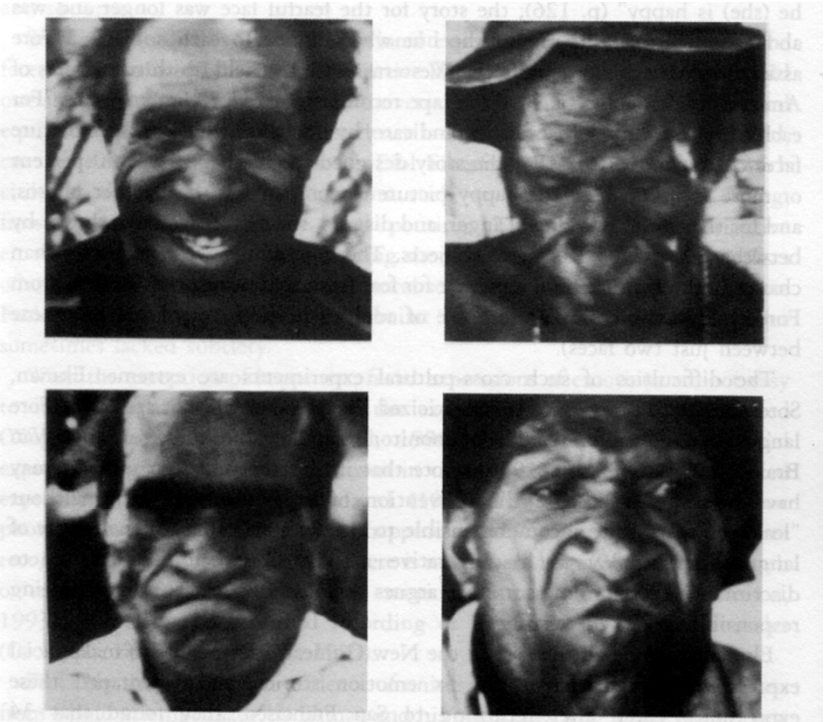


Figure 3.2 Members of the Fore community in New Guinea, who had not seen the photographs for the earlier recognition experiment, enact facial expressions appropriate to stories of emotion (Ekman, 1972): (a) "Your friend has come and you are happy," (b) "Your child has died, and you feel very sad," (c) "You are angry and about to fight," (d) "You are looking at something that smells bad." (The story fragments are from Ekman & Friesen, 1971.) Russell (1994) has criticized experiments on recognizing faces that represent stories because although the researchers hypothesize that a face indicates emotion, it might be recognized as appropriate to a situation: face (d) might not mean disgust but might be made when something smells bad.

Oatley and Jenkins, 2006

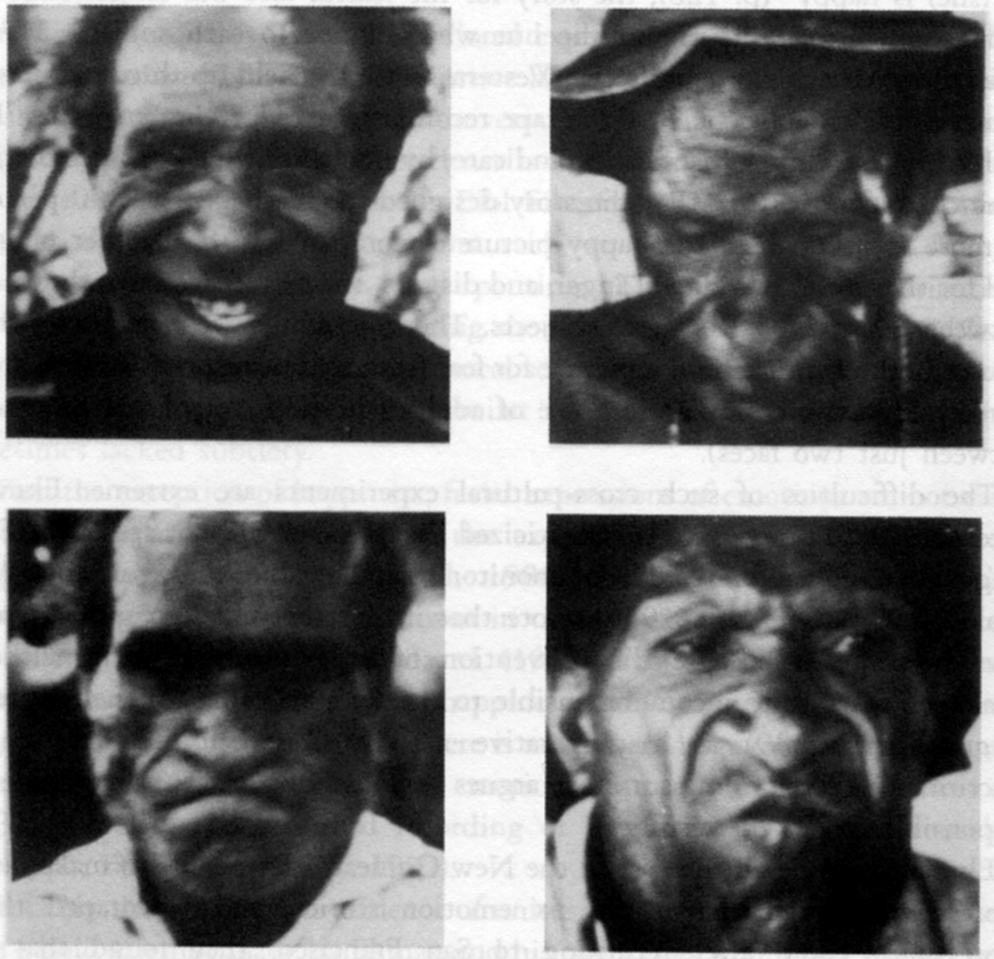


Figure 3.2 Members of the Fore community in New Guinea, who had not seen the photographs for the earlier recognition experiment, enact facial expressions appropriate to stories of emotion (Ekman, 1972): (a) "Your friend has come and you are happy," (b) "Your child has died, and you feel very sad," (c) "You are angry and about to fight," (d) "You are looking at something that smells bad." (The story fragments are from Ekman & Friesen, 1971.) Russell (1994) has criticized experiments on recognizing faces that represent stories because although the researchers hypothesize that a face indicates emotion, it might be recognized as appropriate to a situation: face (d) might not mean disgust but might be made when something smells bad.

American students made between 46 percent and 73 percent correct judgments for happy, sad, angry, disgust expressions but were not correct for fear or surprise.

Oatley and Jenkins, 2006

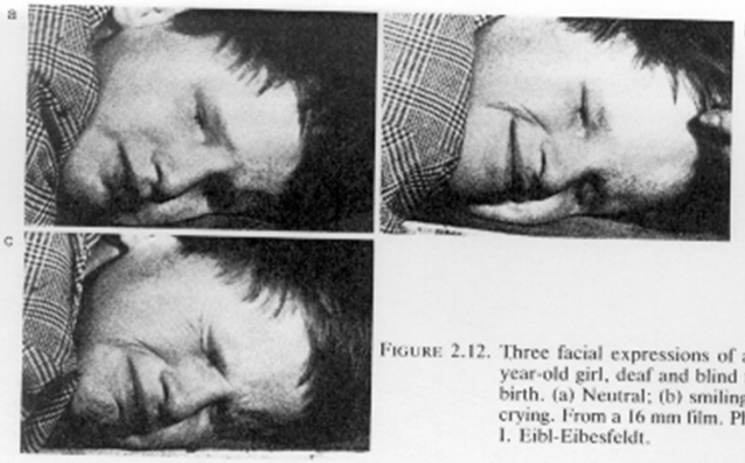


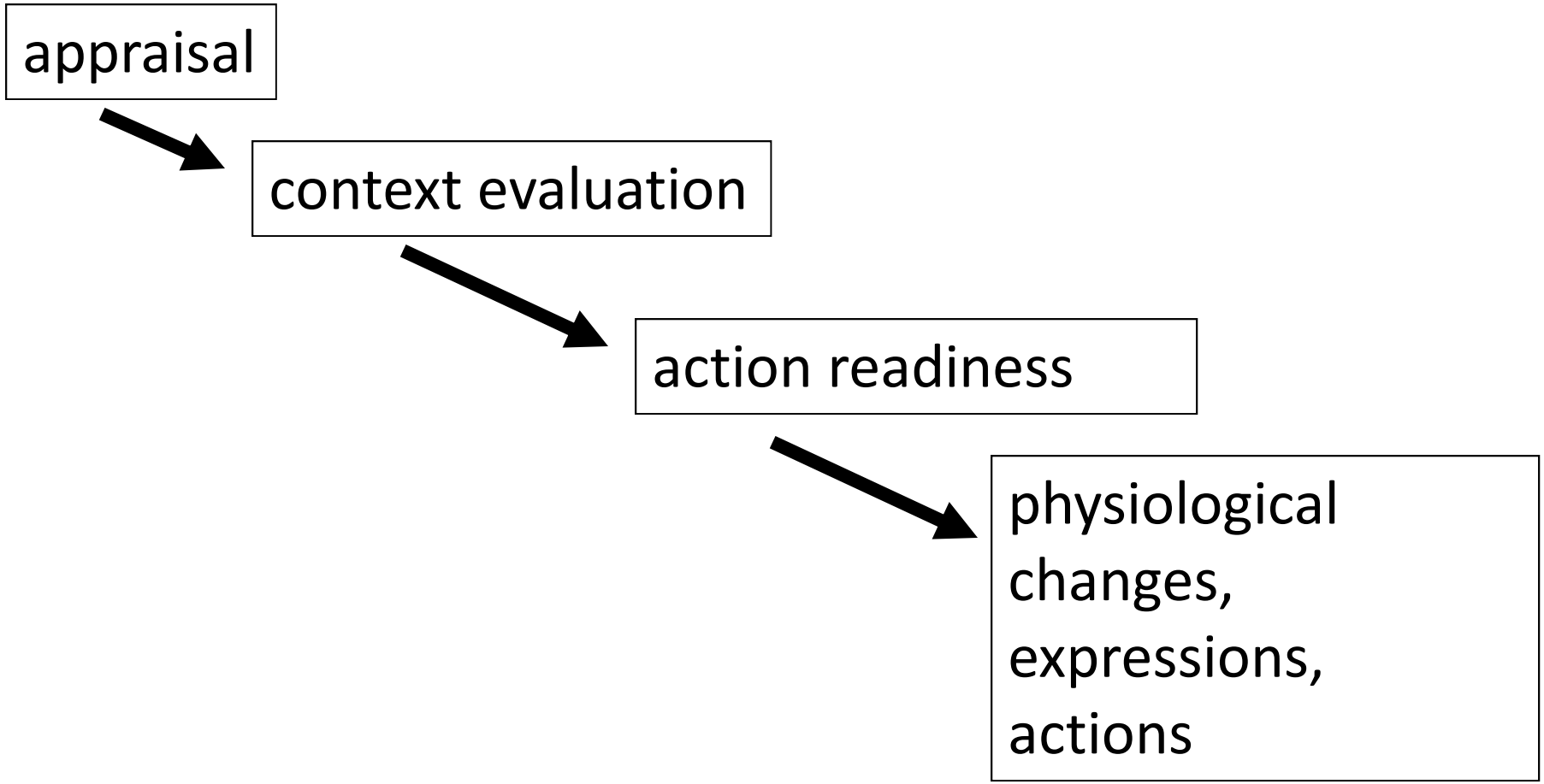
FIGURE 2.12. Three facial expressions of a 10-year-old girl, deaf and blind from birth. (a) Neutral; (b) smiling; (c) crying. From a 16 mm film. Photo: I. Eibl-Eibesfeldt.

FIGURE 2.13. (a) The same girl as seen in Fig. 2.12 expresses anger by biting into her hand. (b) Expression of despair after being left alone. After an angry protest she clasps herself (anger mixed with fear). From a 16 mm film. Photo: I. Eibl-Eibesfeldt.

FIGURE 2.14. The warding-off gesture in the previously shown girl. From a 16 mm film. Photo: I. Eibl-Eibesfeldt.

E. Eibl-Eibesfeldt, 1989

Appraisal theory of emotions -The process of emotion.



Frijda (1985)

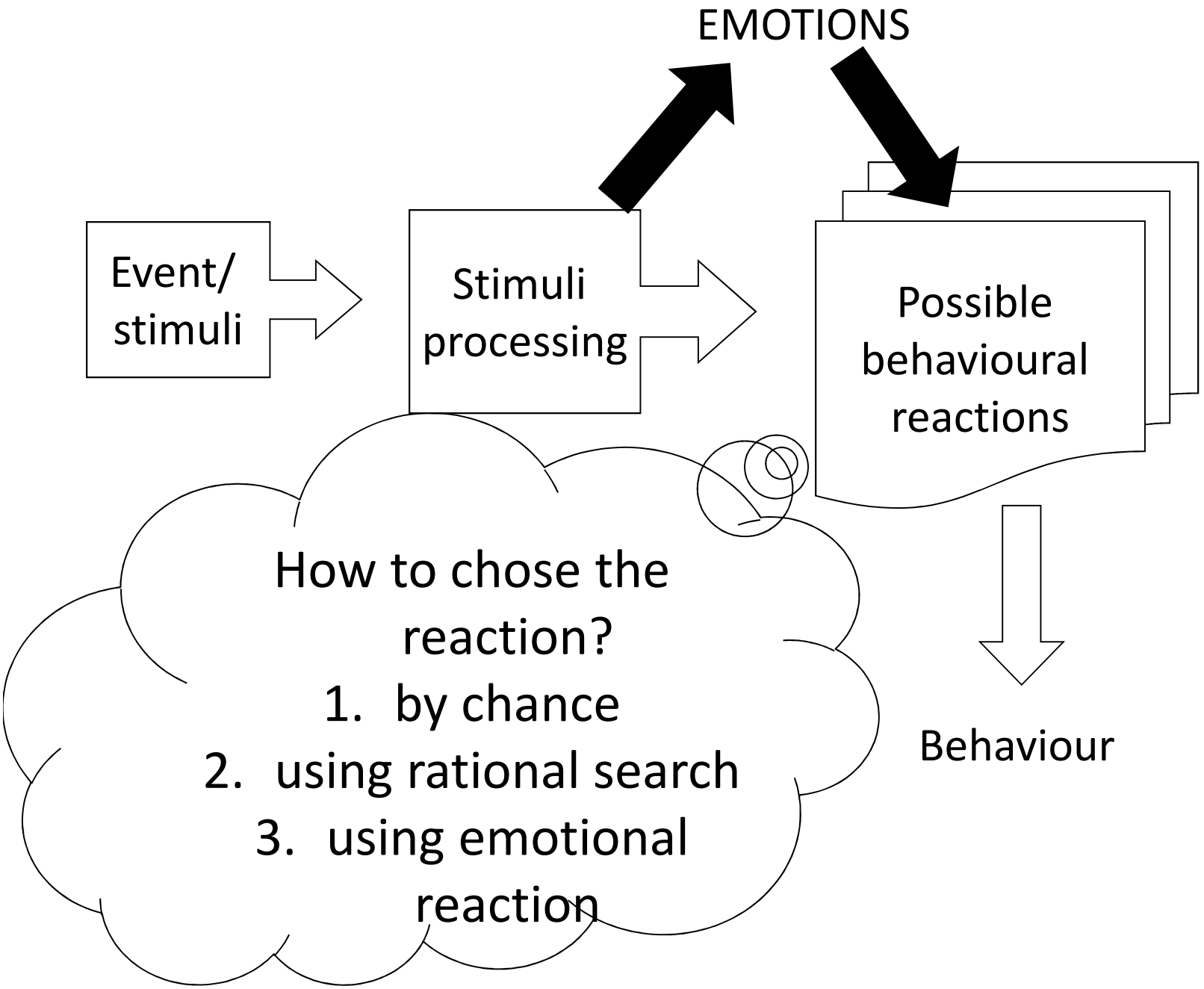
emotional event

1. evaluation of an event as relevant, as important

2. the emotion gives priority to one or few kinds of actions

3. the emotions is usually experienced as a mental state accompanied by bodily changes, expressions, actions

Emotions are heuristics



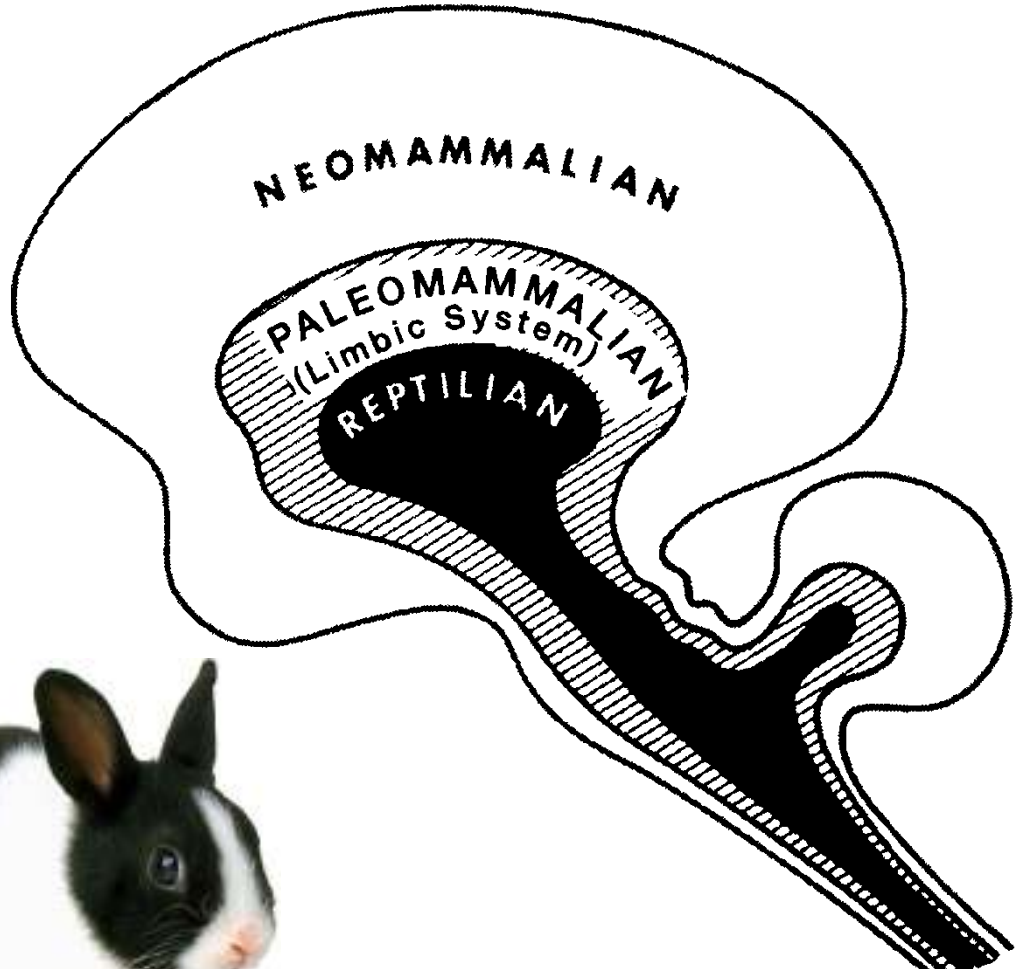
Some emotional stimuli (values) are innate

+

Other emotional stimuli (values) are learned,

MacLean theory
(*theory of the Limbic System*)

Paul D. MacLean
(1913-2007)



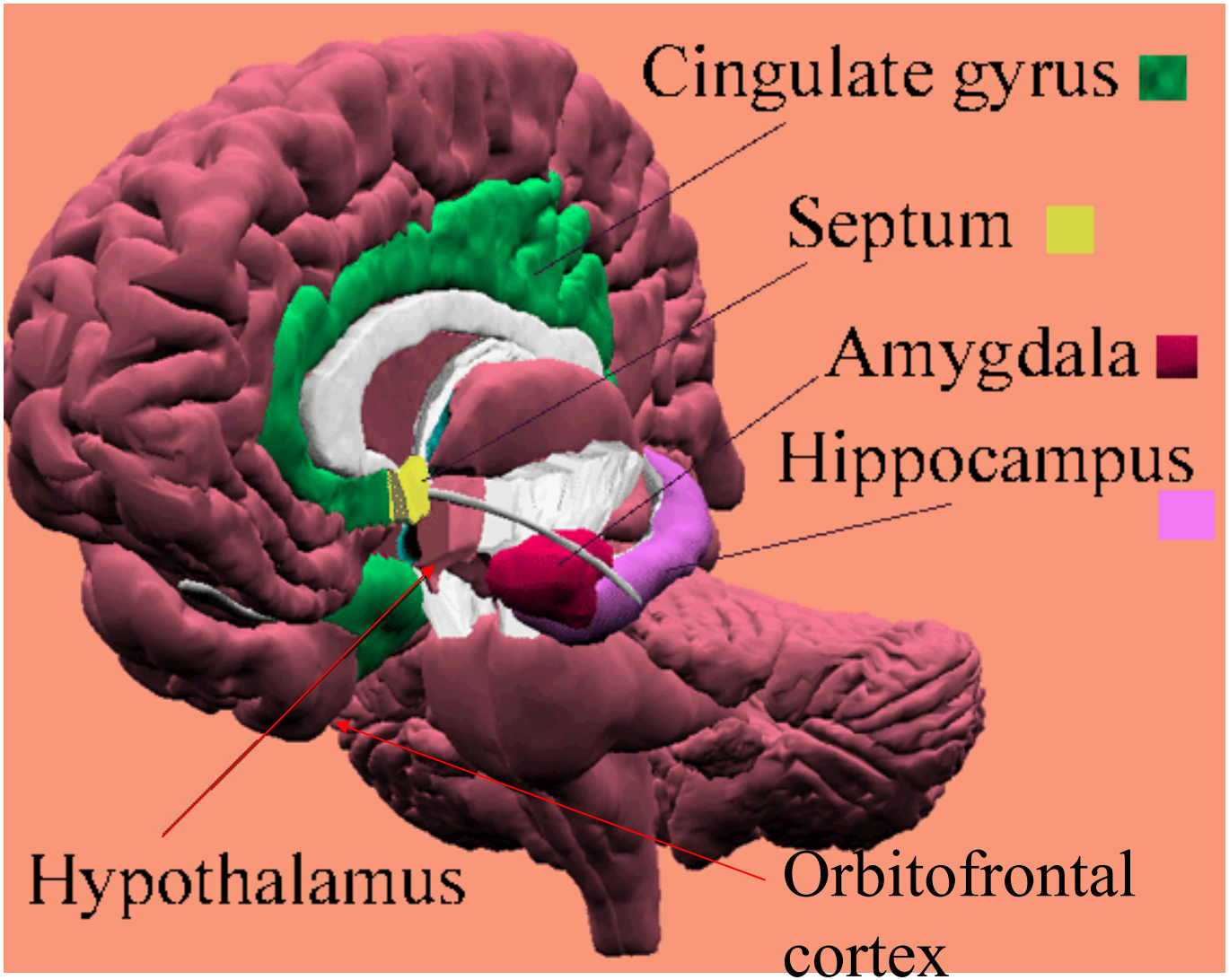
Oatley and Jenkins, 2006

Theory of Limbic system

- **Limbic system** is the evolutionary new system and it's formation was connected with a dramatic revolution in the social, emotional and parent behaviour of mammalians in comparison with reptiles.

- The damage of these structures leads to crucial abnormalities in sexual, emotional social and feeding behaviour.

The limbic system



I think… the idea that there is an emotion system in the brain, is misguided.

I've come to think that emotions are products of different systems, each of which evolved to take care of problems of survival…

Joseph LeDoux
2.17.1997

~ Emotions are states elicited by stimuli with subjective values (utility≠ 0)

Emotions are states elicited by rewards and punishers, including changes in reward and punishment.

E.Rolls

Different emotions

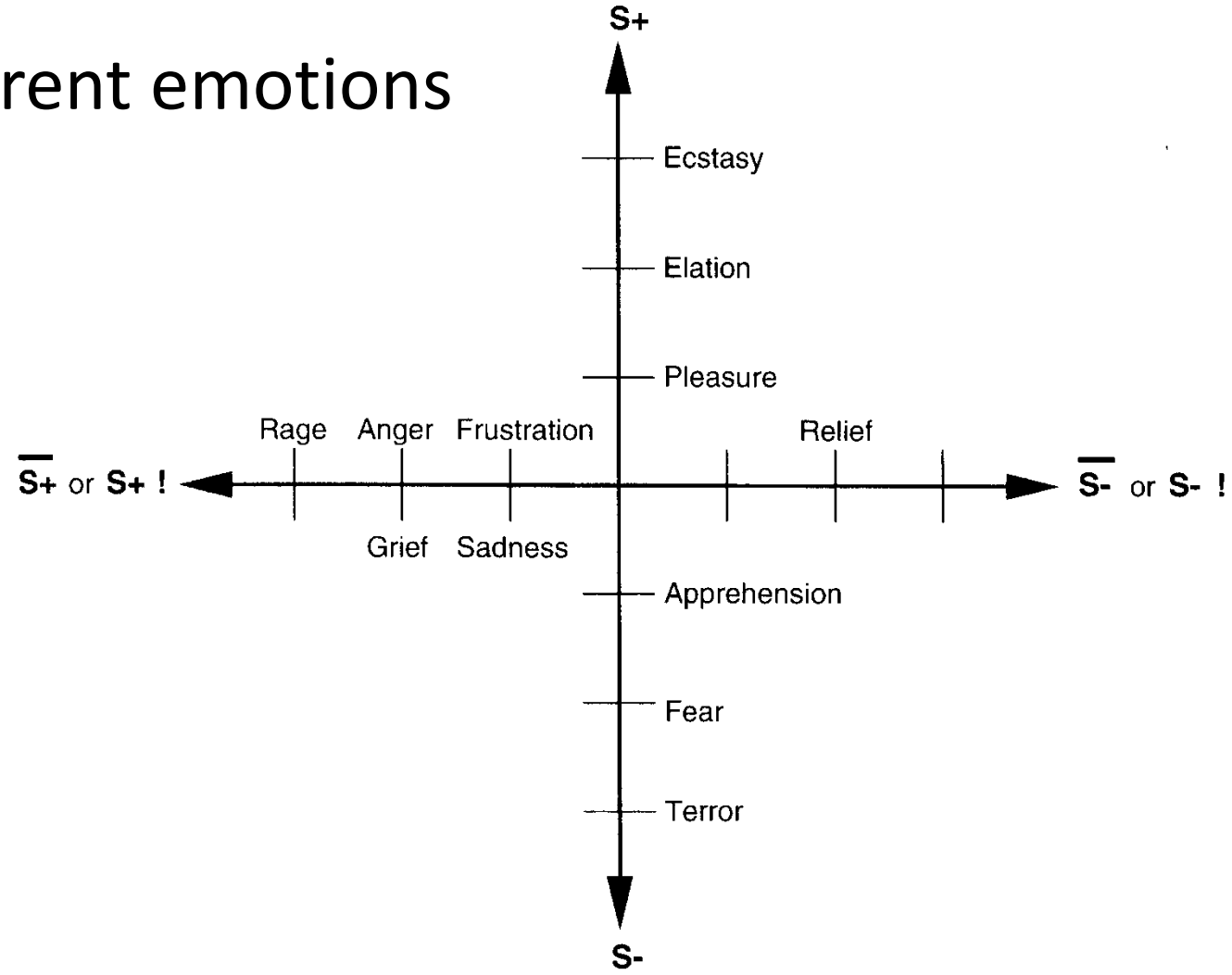
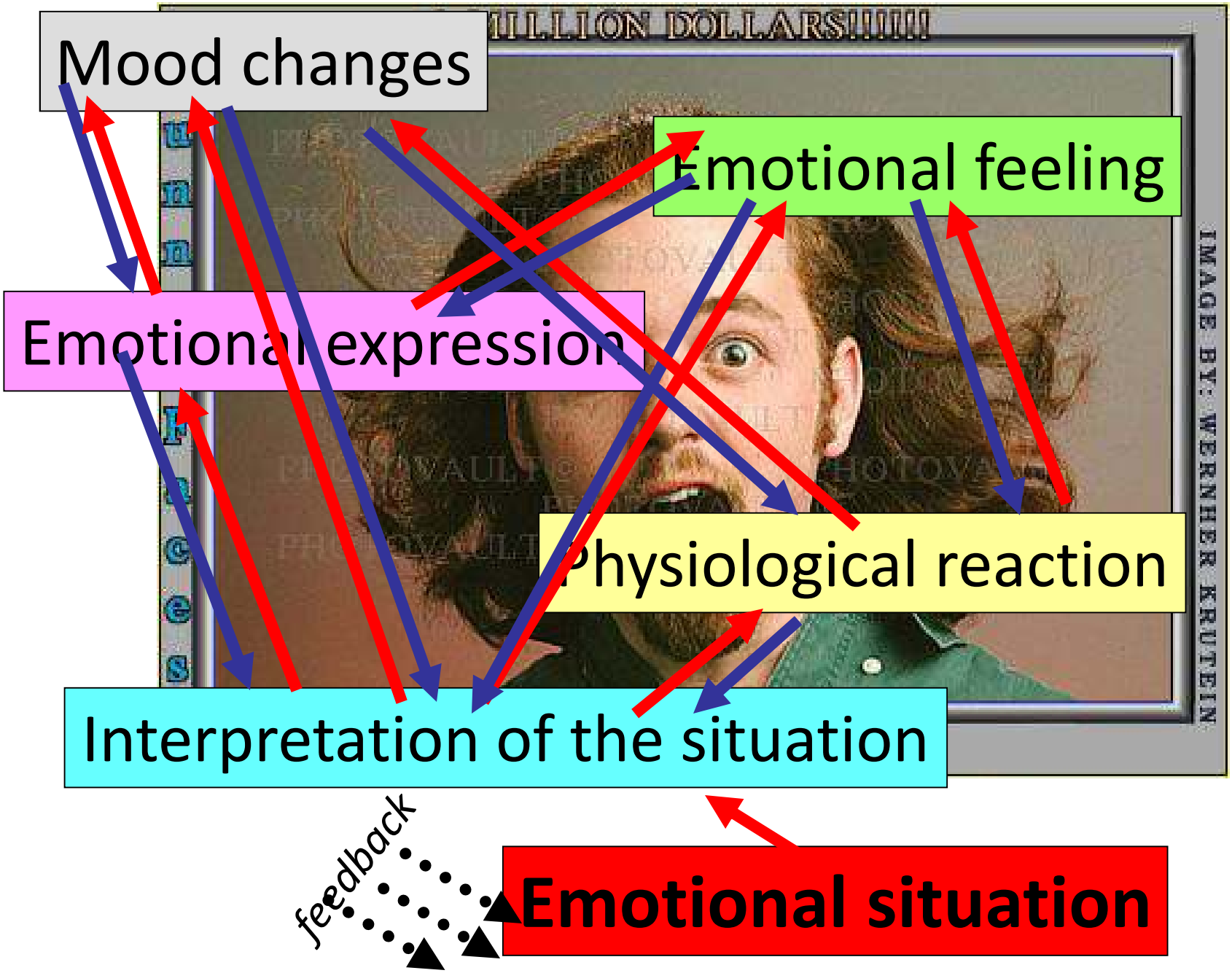


Fig. 3.1 Some of the emotions associated with different reinforcement contingencies are indicated. Intensity increases away from the centre of the diagram, on a continuous scale. The classification scheme created by the different reinforcement contingencies consists of: (1) the presentation of a positive reinforcer (S+); (2) the presentation of a negative reinforcer (S−); (3) the omission of a positive reinforcer ($\overline{S+}$) or the termination of a positive reinforcer (S+!); and (4) the omission of a negative reinforcer ($\overline{S-}$) or the termination of a negative reinforcer (S−!).

Rolls, 1999

Emotions ≥ subjective value ~ utility


Mood changes
Emotional feeling
Emotional expression
Physiological reaction
Interpretation of the situation
feedback
Emotional situation

Emotion is more than utility

- Emotions ≥ subjective value ~ utility
- Utility is a component of emotions
- Utility is coded by emotional neural networks
- In decision theory, **utility** is a measure of the desirability of consequences of an action

Sensory processing

Emotional value; Behavioural reactions

Internal status (hunger)

Learning (is an object a food or not)

Body (peripheral) signals for hunger and satiety

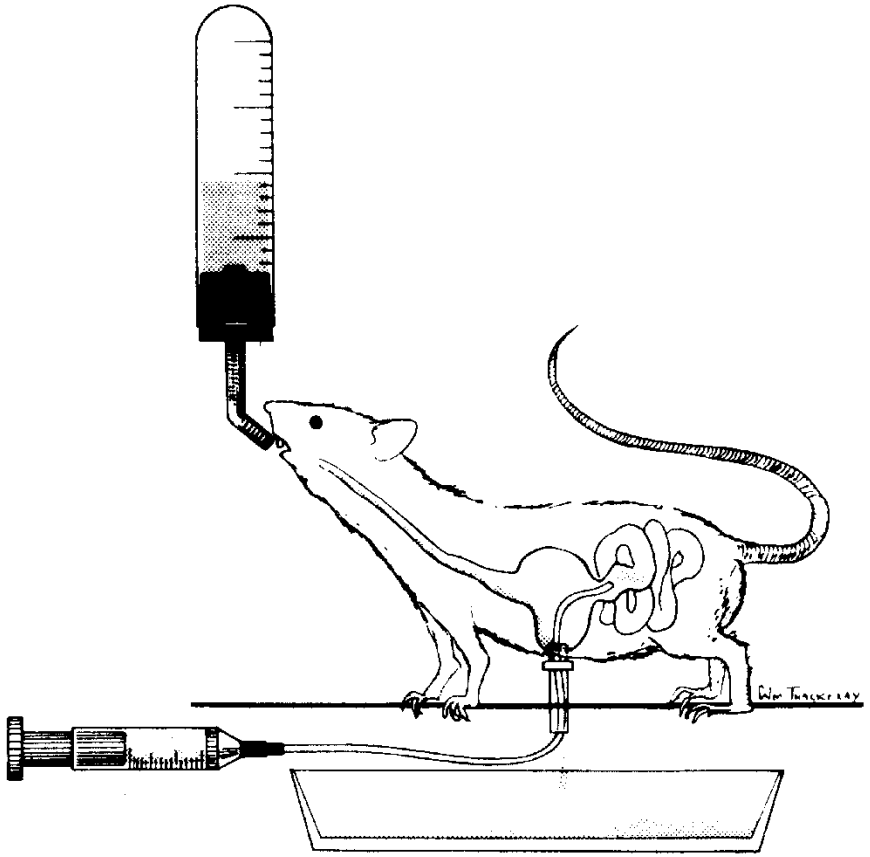
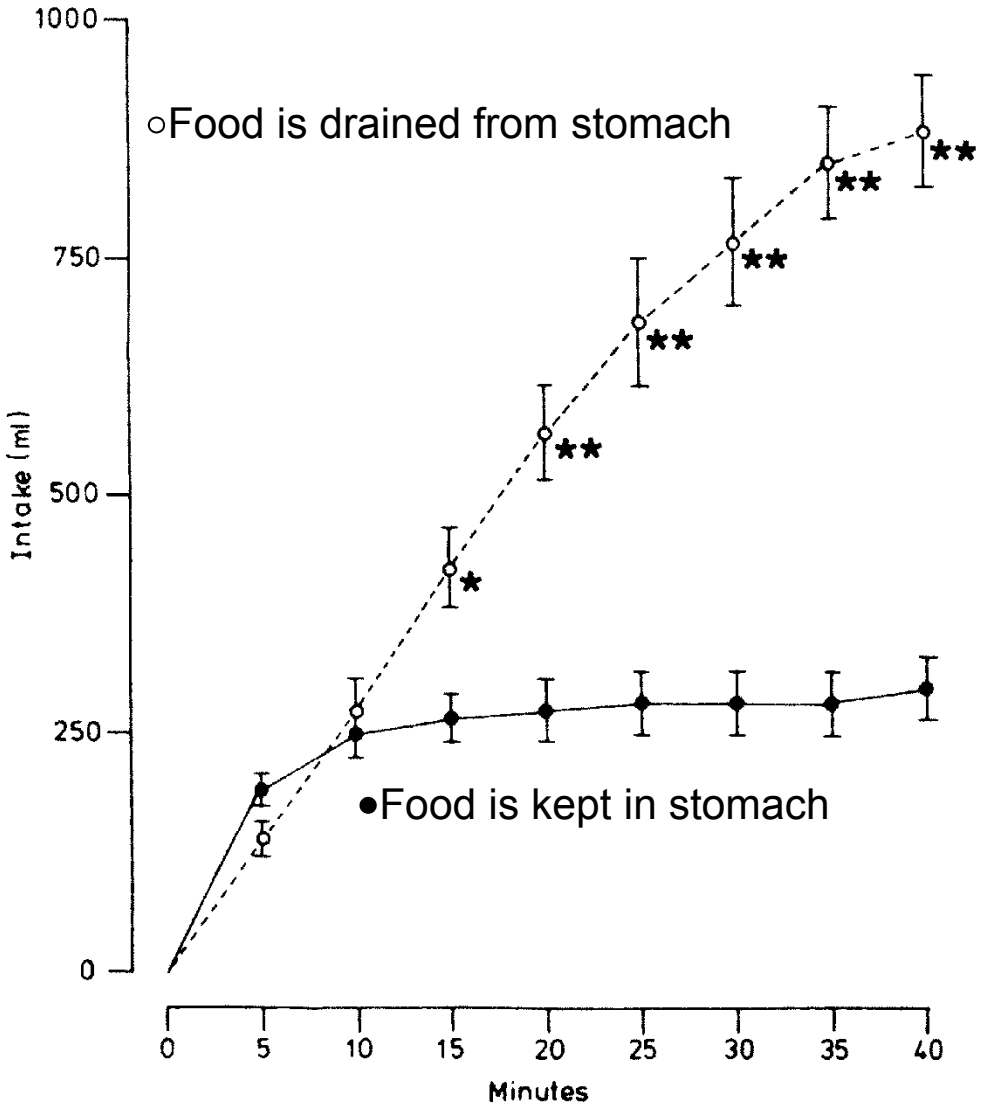


Fig. 2.1 Sham feeding preparation. Food can be tasted, smelled and ingested normally, but then it drains from the stomach so that gastric distension and other gastrointestinal factors are not produced. The diagram also shows a cannula entering the duodenum, so that the role of intestinal factors in eating can be studied by infusions of for example potential satiety–producing substances.

Rolls, 1999



- Reward is produced by sensory signals.
- Satiety is produced by gastric, internal signals of food absorption.

Fig. 2.2 Sham feeding in the monkey. The cumulative intakes of food with normal feeding (gastric cannula closed, closed circles), and with the gastric cannula open (open circles) allowing drainage of food from the stomach, are shown. The stars indicate significant differences between the open and closed gastric cannula conditions. (From Gibbs, Maddison and Rolls 1981.)

Rolls, 1999

Internal Organs of the Human Body

The brain is the command center of the central nervous system. It receives signals that tell the body what to do and controls both voluntary and involuntary activities. The brain is the home of emotion, memory, thought, and language.

The lungs are the main component of the respiratory system. They distribute air and exchange gases, removing carbon dioxide from the blood and providing it with oxygen.

The heart pumps the body's entire volume of blood to and from the lungs (using the right ventricle and left atrium) and to and from all the organs (using the left ventricle and right atrium).

The diaphragm plays a vital role in breathing. As it contracts and flattens, it helps draw air into the lungs; as it relaxes, it helps push the air out of the lungs.

The liver, the largest internal organ, and performs complex and important functions related to digestion and nutrition. The liver produces bile (which helps break down food matter in the small intestine), detoxifies blood, helps regulate blood glucose levels, and produces plasma proteins.

The kidneys eliminate waste, filter blood, maintain fluid-electrolyte and acid-base balances, produce the hormone that stimulates the production of red blood cells, produce enzymes that govern blood pressure, and help activate vitamin D.

The spleen breaks down old red blood cells and selectively retains and destroys damaged or abnormal red blood cells. It also filters out bacteria and other foreign substances that enter the bloodstream. The spleen stores blood and produces cells involved in immune response.

The gallbladder stores the bile that is secreted by the liver.

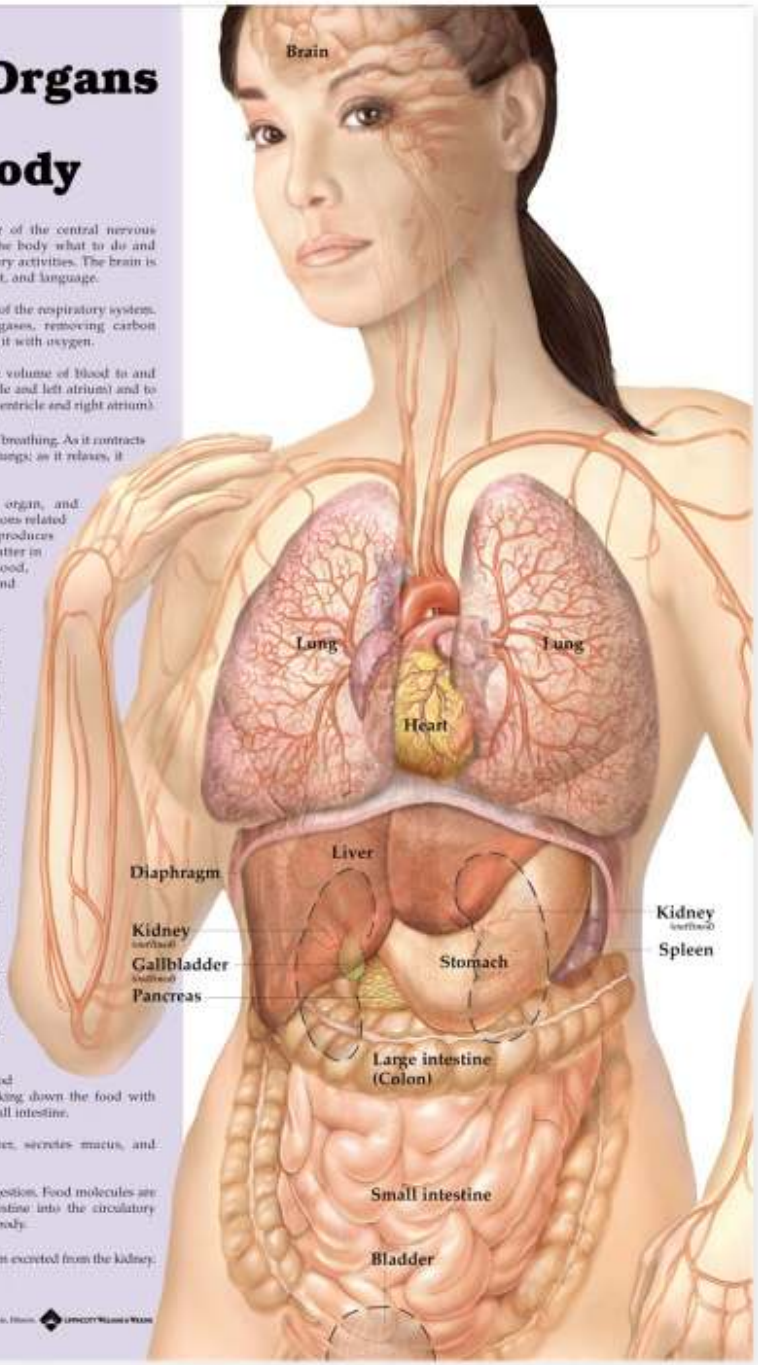
The pancreas assists with the digestion of many substances such as protein, nucleic acids, starch, fats and cholesterol. Using the hormone insulin, the pancreas controls the amount of sugar stored in and released from the liver for use throughout the body.

The stomach temporarily stores food and begins the digestion process, breaking down the food with gastric acids and moving it into the small intestine.

The large intestine absorbs water, secretes mucus, and eliminates digestive waste.

The small intestine completes digestion. Food molecules are absorbed through the wall of the intestine into the circulatory system and delivered to the cells of the body.

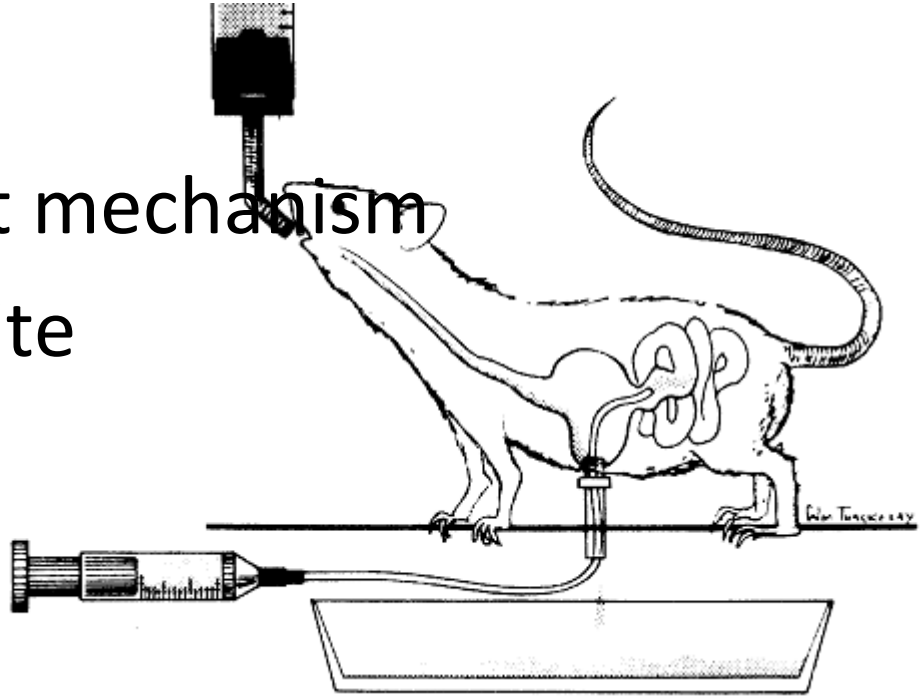
The bladder stores urine that has been excreted from the kidney.



The control signals for hunger and satiety.

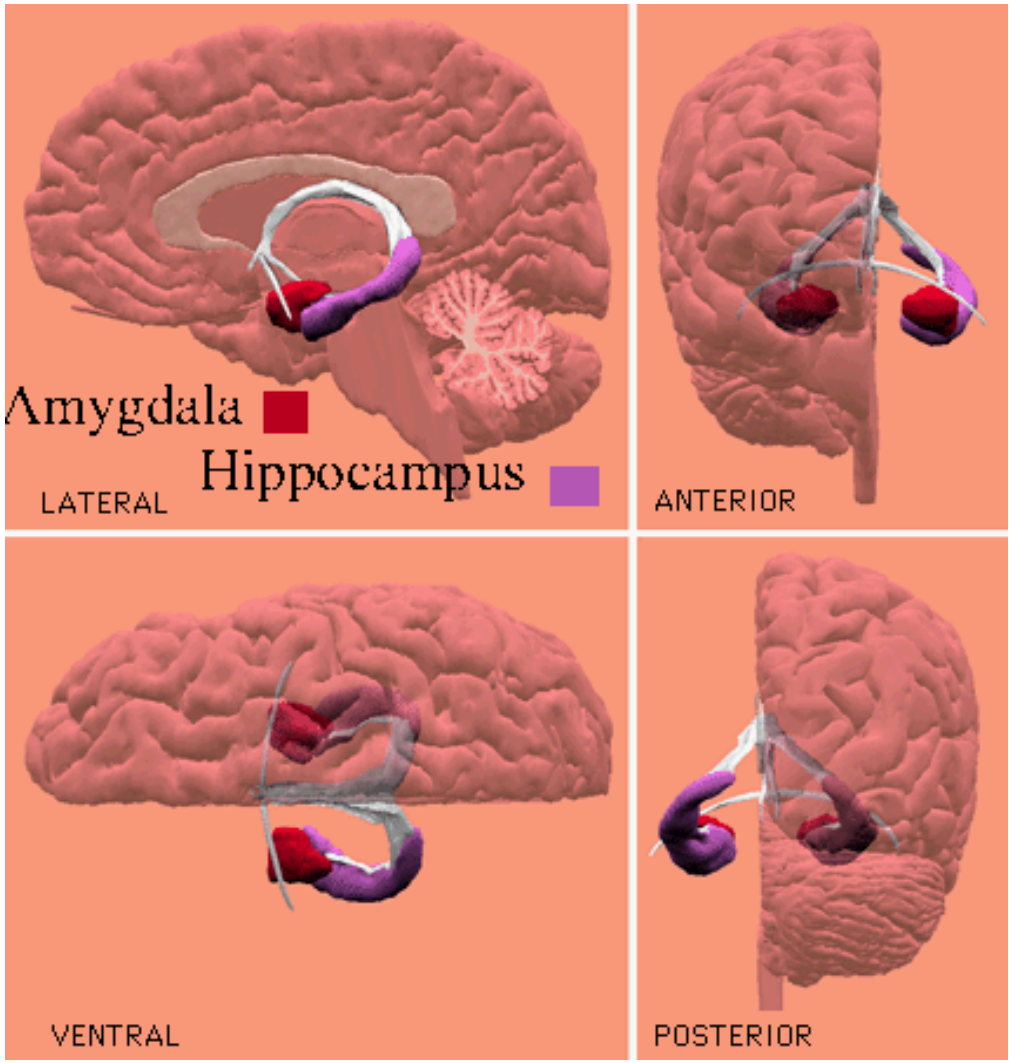
- Gastric distension
- Chemo-sensors
- Glucostatic hypothesis
- Body fat regulation
- Sensory dependent mechanism
- Conditioned appetite

and satiety

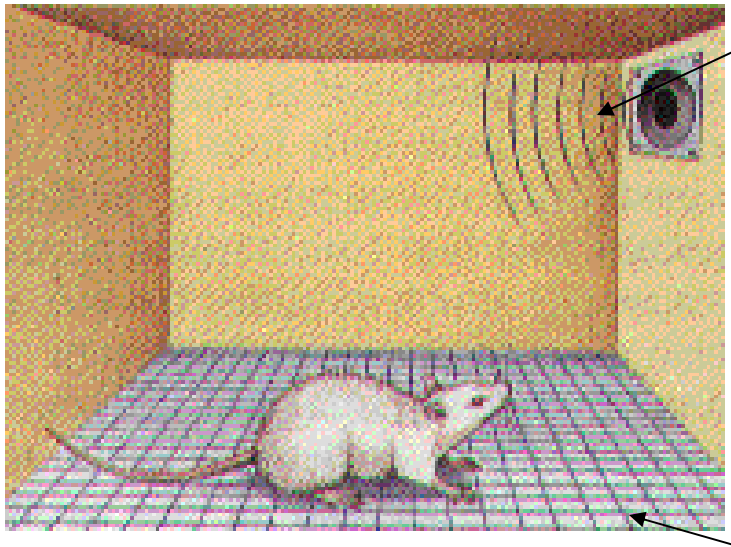


Region	**Main Functions**
Ventral striatum (NA)	anticipated value
Orbitofrontal cortex/ *ventral medial prefrontal cortex*	derives an integrated value signal, learn values
Insular cortex (IC)	awareness of body states, emotions (e.g. disgust)
Amygdala	emotion-related learning (e.g. fear conditioning)
anterior/dorsal Cingulate cortex	conflict monitoring, behavioral adjustments
Hypothalmus	links the nervous system to the endocrine system

Amygdala – an emotional computer.

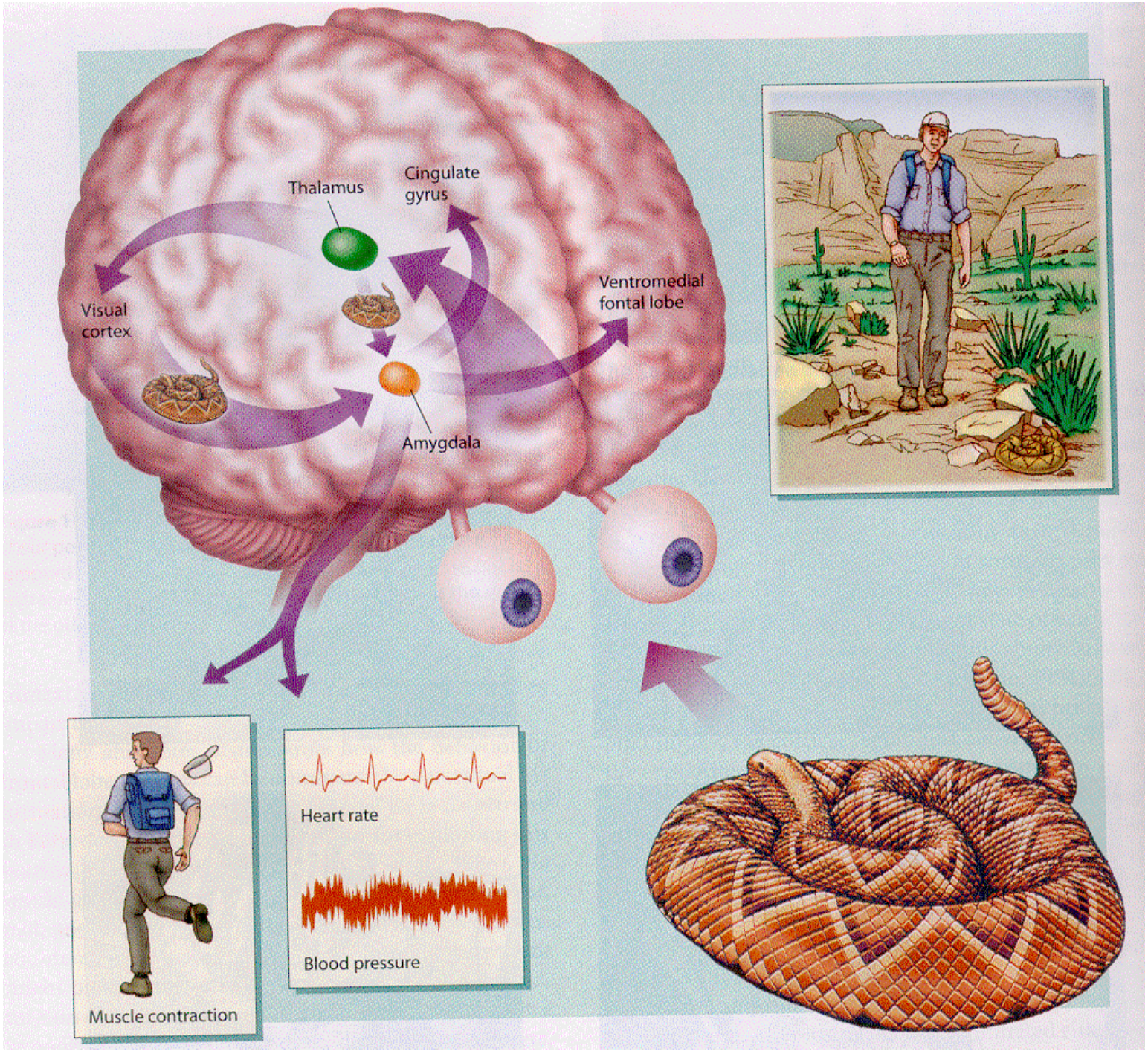


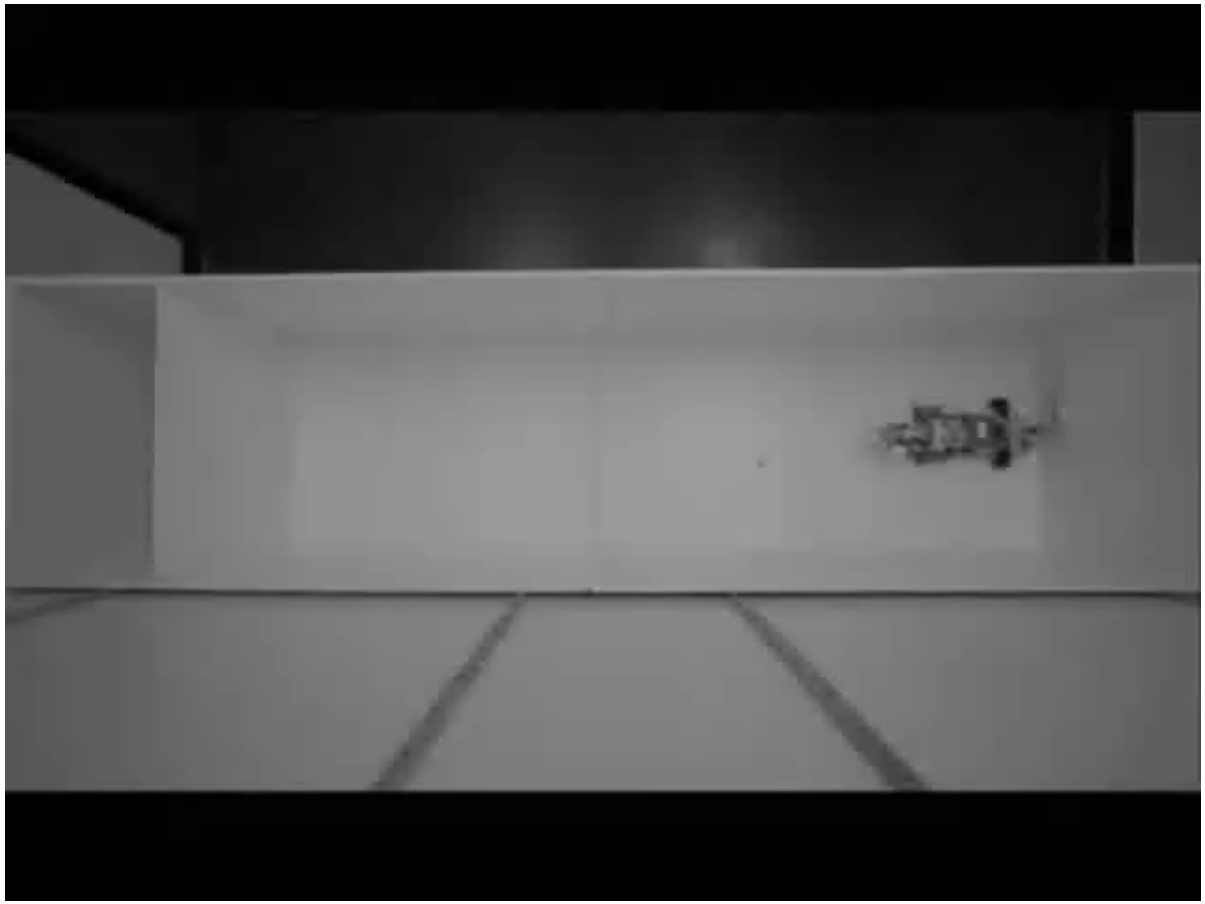
Joseph LeDoux elaborated a rat fear reaction to the simple auditory stimulus by combination of this auditory stimulus with painful electrical shock.

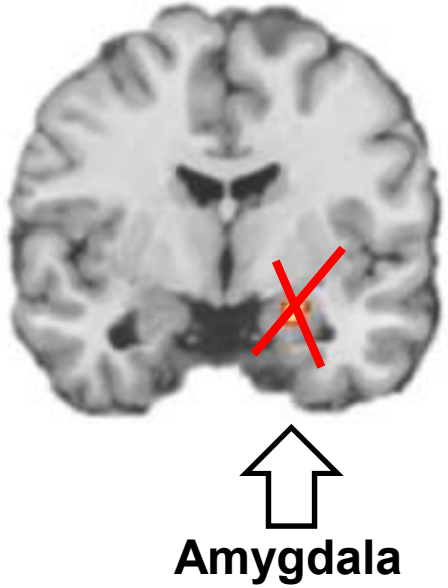


CS - Auditory stimulus

US - Electrical foot shock


Thalamus
Cingulate gyrus
Visual cortex
Ventromedial fontal lobe
Amygdala
Heart rate
Blood pressure
Muscle contraction

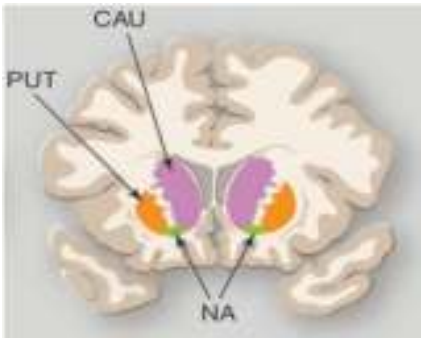



Amygdala

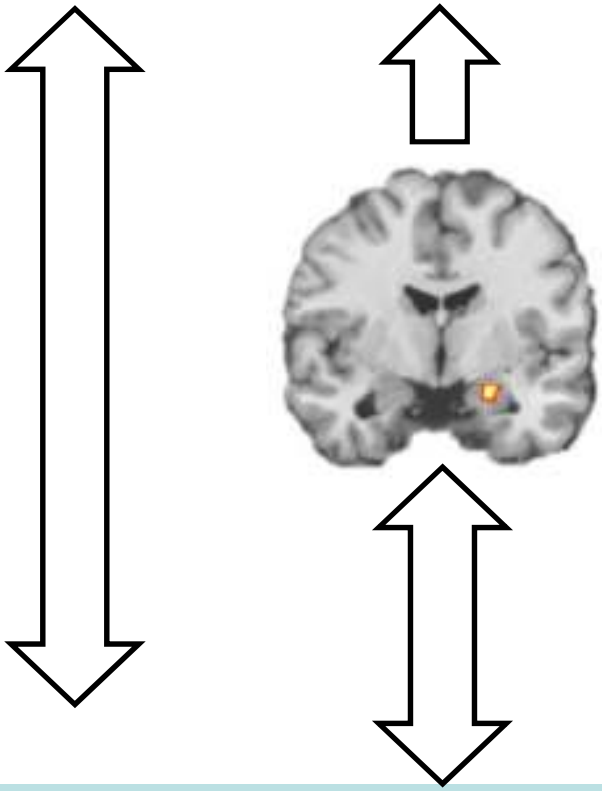
Role of amygdala:

- Processing of the ”negative” information/costs
- Conditioning processes (learning)
- Emotional memory
- Triggers vegetative reactions

Region	**Main Functions**
Ventral striatum (NA)	anticipated value
Orbitofrontal cortex/ *ventral medial prefrontal cortex*	derives an integrated value signal, learn values
Insular cortex (IC)	awareness of body states, emotions (e.g. disgust)
Amygdala	emotion-related learning (e.g. fear conditioning)
anterior/dorsal Cingulate cortex	conflict monitoring, behavioral adjustments
Hypothalmus	links the nervous system to the endocrine system

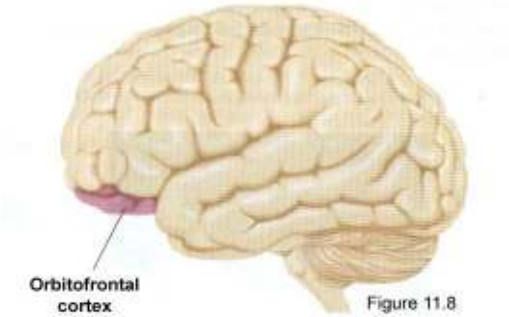


Nucleus accumbens (NAc) – subjective value / anticipated gain magnitude.

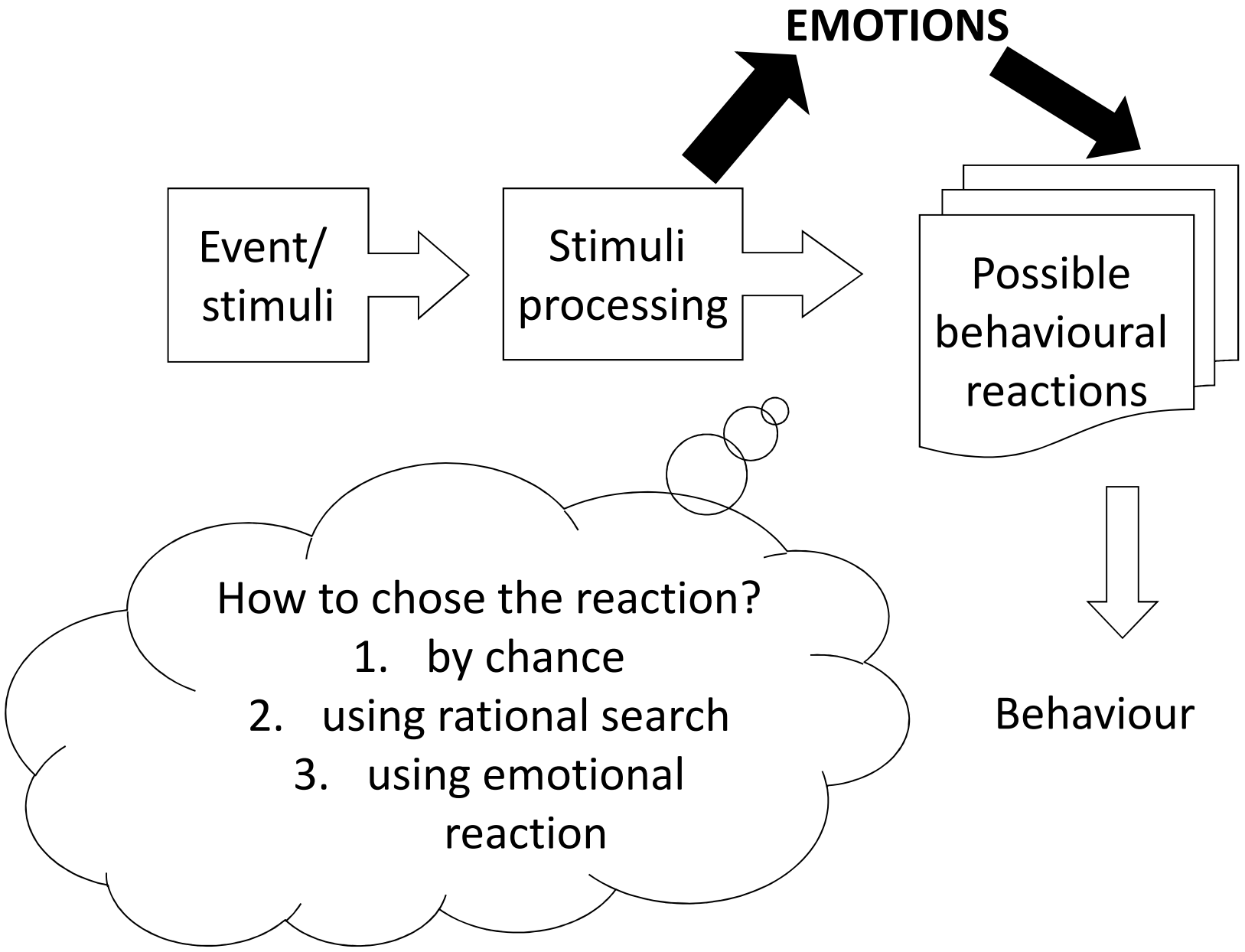


Amygdala – learning / costs analysis, fear.

Orbitofrontal cortex (OFC) – compares / integrates multiple information regarding the reward outcome



Emotions are heuristics



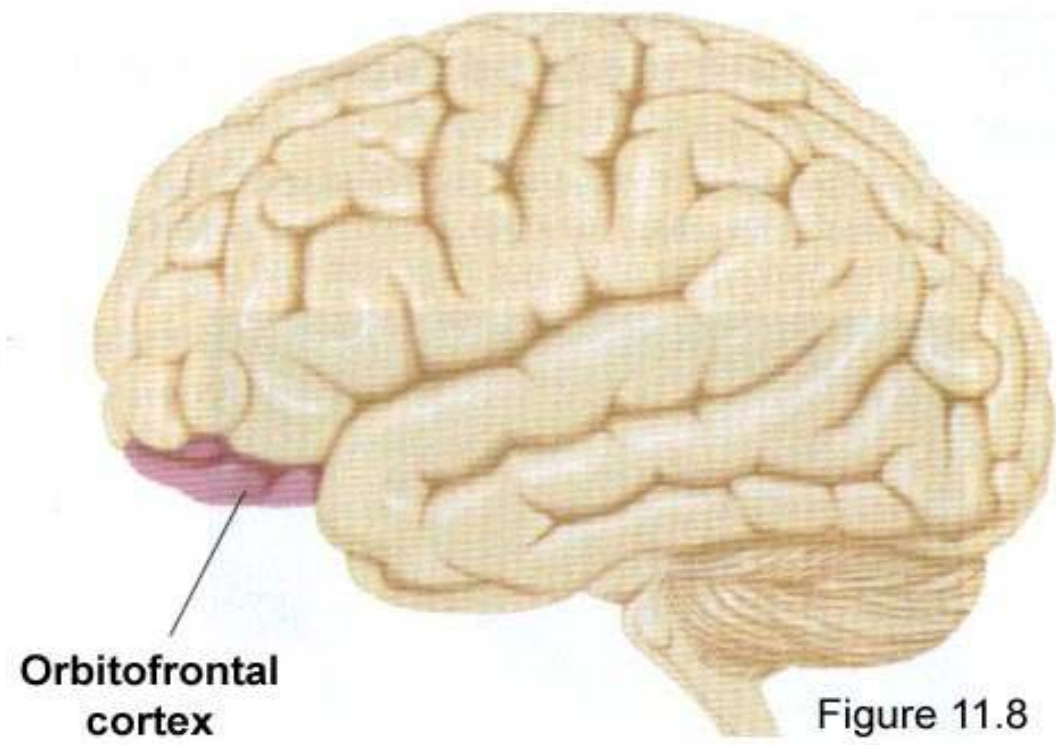


Figure 11.8

Orbitofrontal cortex (OFC) – compares / integrates multiple information regarding the reward outcome

Fast emotional (reverse) learning

Elliott

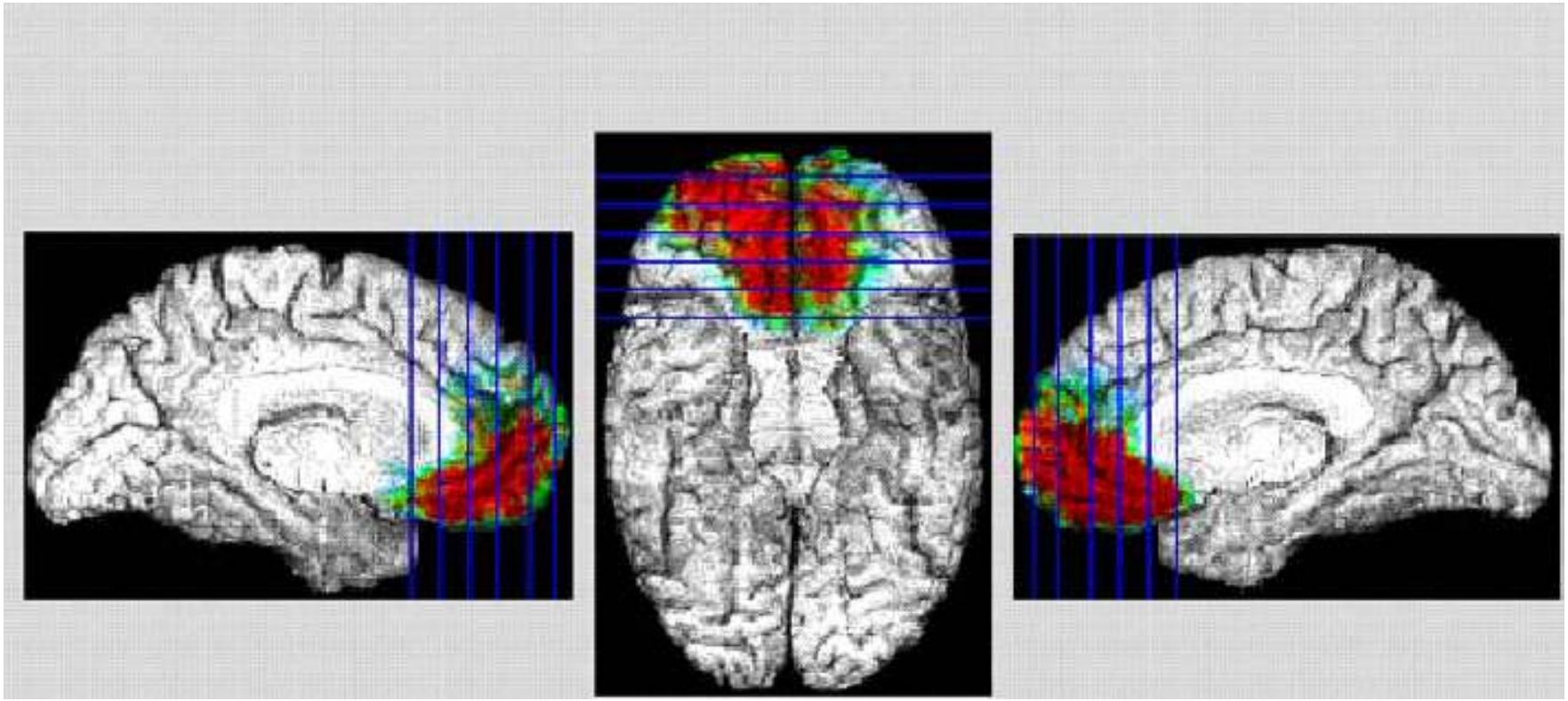
- Elliott, a happily married young man in his thirties - a role model and a natural leader through the ranks of a building firm to become a financial controller at the age of 32.
- At the age of 35 doctors diagnosed Elliot with a brain tumor. The surgery damaged OFC.
- Tests of his intelligence, memory, reading and writing comprehension, verbal fluency, visuospatial abilities, and facial recognition revealed average to superior performance.

António Damásio
neurologist and neuroscientist

Elliott

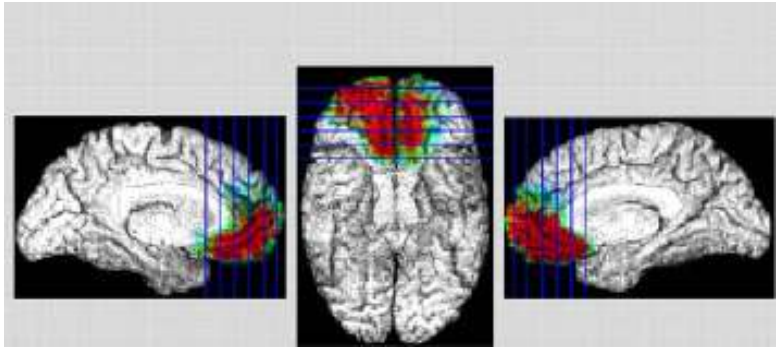
- Within months of the operation, he had quit his job, lost a large sum of money to a scam artist, divorced his wife, lost contact with family and friends, and remarried a prostitute he had known for a month.
- Employers complained about his tardiness and disorganization. His second marriage ended in divorce six months later, and he moved in with his parents.
- Here then is the paradox of OFC: How can damage to this area leave so many of our cognitive abilities intact, yet devastate our decisions.

Antonio Damasio's patients:



Orbitofrontal / ventromedial prefrontal cortex

Antonio Damasio's patients:



1. have frontal lobe disorders
2. have averaged or above averaged intelligence
3. are unexpressive of emotions and unusually rational
4. in real life patients make disastrous decisions. They can lose jobs, friend, family, colleagues

Unemotional people, ironically, can't react rationally!!!!!

The somatic marker hypothesis (A. Damasio)

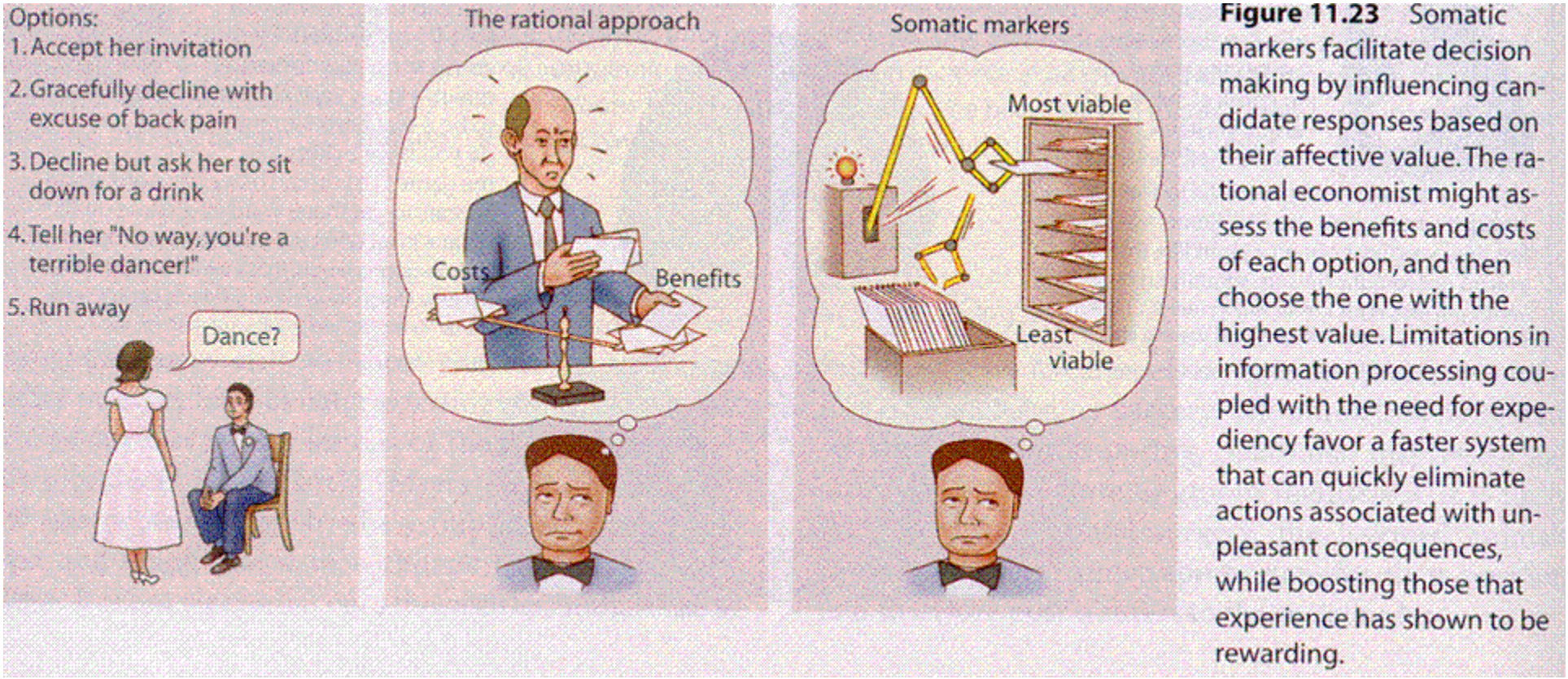


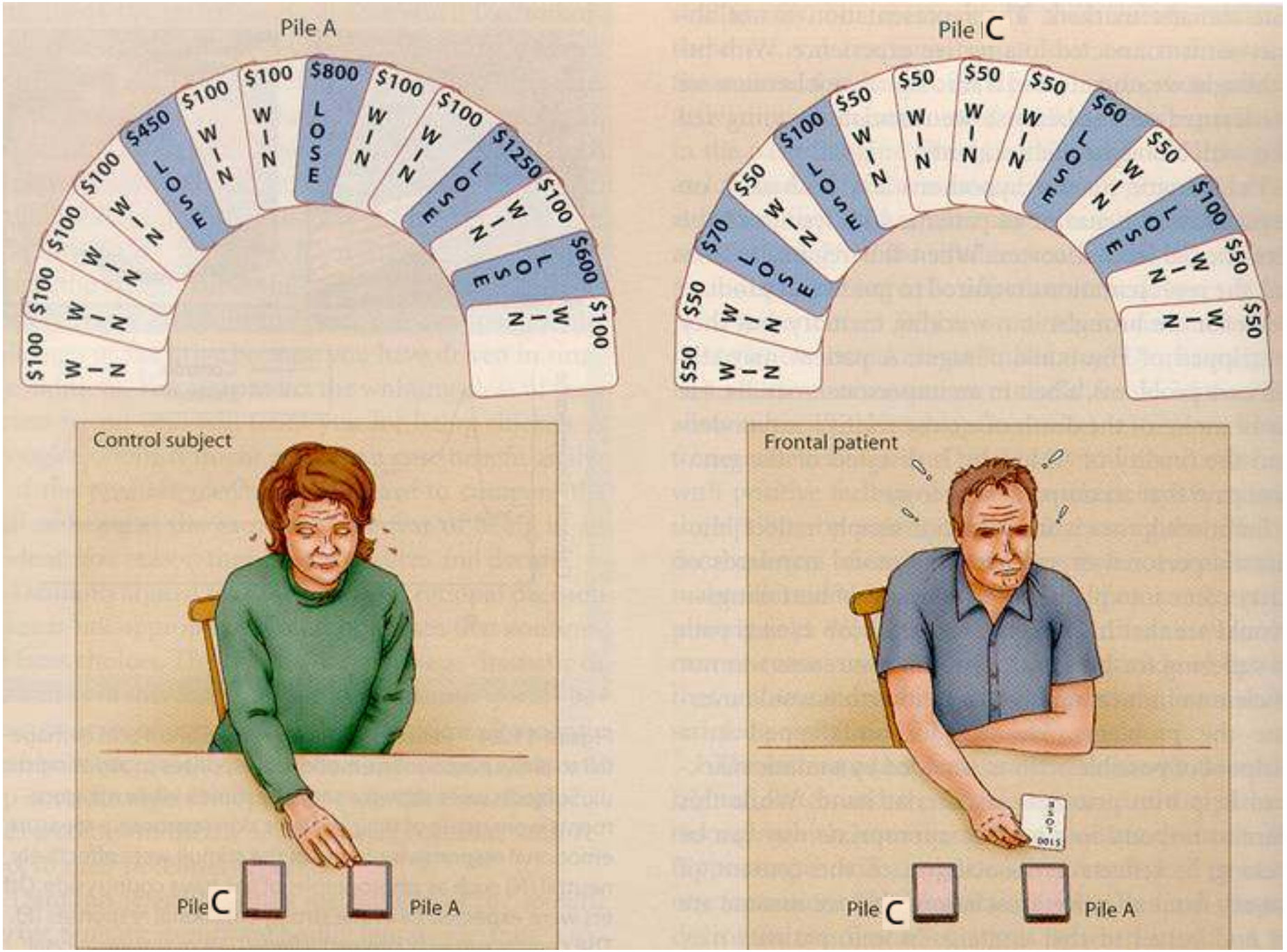
Figure 11.23 Somatic markers facilitate decision making by influencing candidate responses based on their affective value. The rational economist might assess the benefits and costs of each option, and then choose the one with the highest value. Limitations in information processing coupled with the need for expediency favor a faster system that can quickly eliminate actions associated with unpleasant consequences, while boosting those that experience has shown to be rewarding.

Gazzaniga et al. (2008)

Deciding Advantageously Before Knowing the Advantageous Strategy

Antoine Bechara, Hanna Damasio, Daniel Tranel, Antonio R. Damasio*

Deciding advantageously in a complex situation is thought to require overt reasoning on declarative knowledge, namely, on facts pertaining to premises, options for action, and outcomes of actions that embody the pertinent previous experience. An alternative possibility was investigated: that overt reasoning is preceded by a nonconscious biasing step that uses neural systems other than those that support declarative knowledge. Normal participants and patients with prefrontal damage and decision-making defects performed a gambling task in which behavioral, psychophysiological, and self-account measures were obtained in parallel. Normals began to choose advantageously before they realized which strategy worked best, whereas prefrontal patients continued to choose disadvantageously even after they knew the correct strategy. Moreover, normals began to generate anticipatory skin conductance responses (SCRs) whenever they pondered a choice that turned out to be risky, before they knew explicitly that it was a risky choice, whereas patients never developed anticipatory SCRs, although some eventually realized which choices were risky. The results suggest that, in normal individuals, nonconscious biases guide behavior before conscious knowledge does. Without the help of such biases, overt knowledge may be insufficient to ensure advantageous behavior.



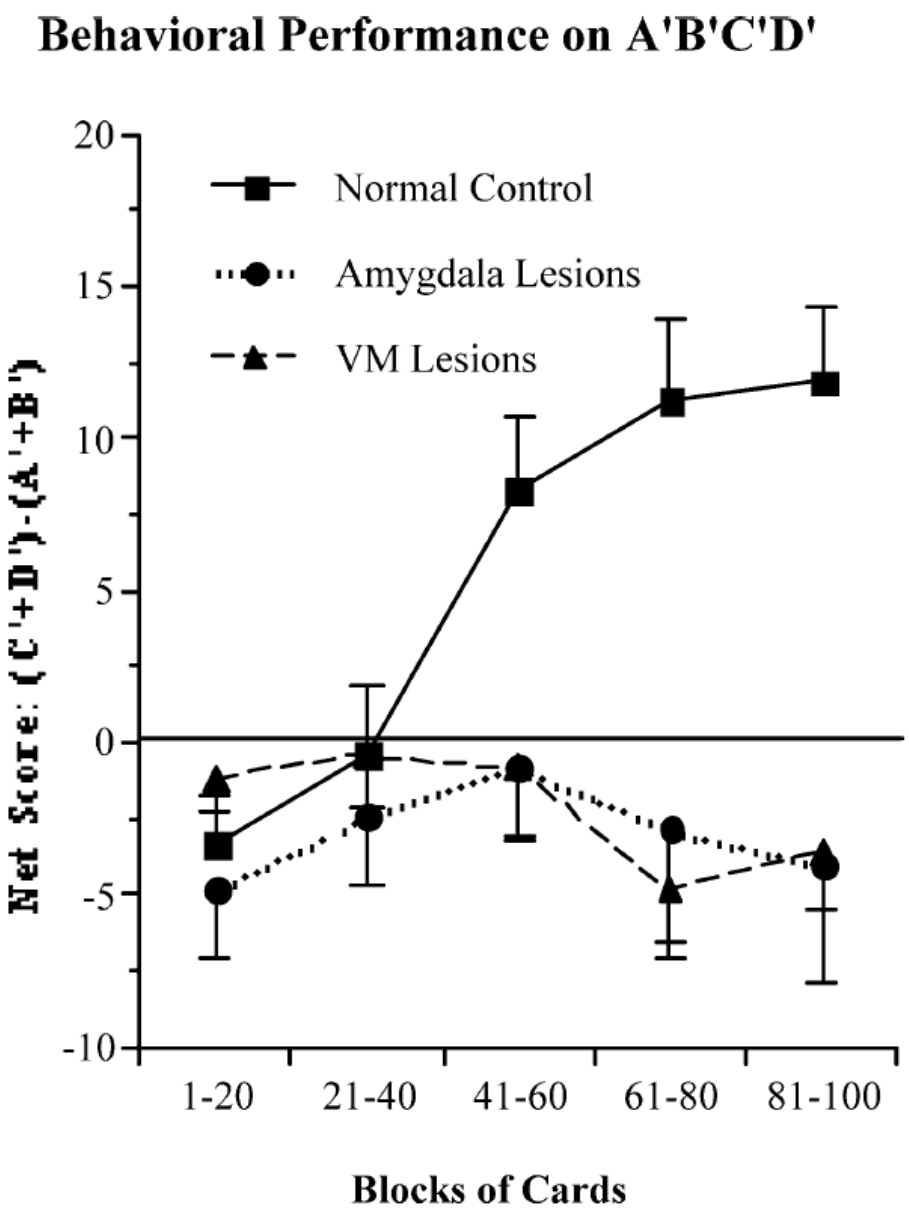
Gazzaniga et al. (2008)

Table 1

The gain-loss structure in the original IGT.

Deck Card Sequence	A	B	C	D
1	100	100	50	50
2	100	100	50	50
3	100, **-150**	100	50, **-50**	50
4	100	100	50	50
5	100, **-300**	100	50,**-50**	50
6	100	100	50	50
7	100, **-200**	100	50, **-50**	50
8	100	100	50	50
9	100, **-250**	100, **-1250**	50, **-50**	50
10	100, **-350**	100	50, **-50**	50, **-250**
Final Outcomes	**-250 ($)**	**-250 ($)**	**+250 ($)**	**+250 ($)**
Gain-loss Frequency	**5 gains 5 losses**	**9 gains 1 loss**	**5 gains 5 losses**	**9 gains 1 loss**

Ching-Hung et al. 2012

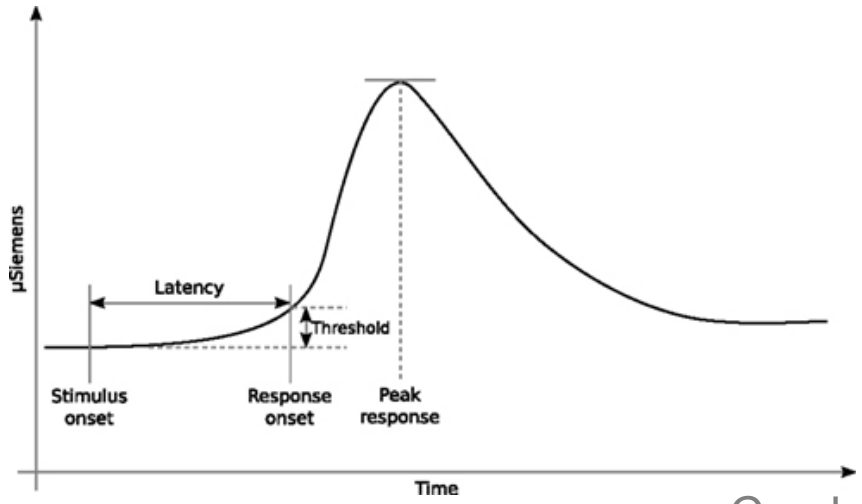


decks of cards (***A*** and ***B***) yield high immediate gain but larger future loss, i.e. long term loss (disadvantageous decks)

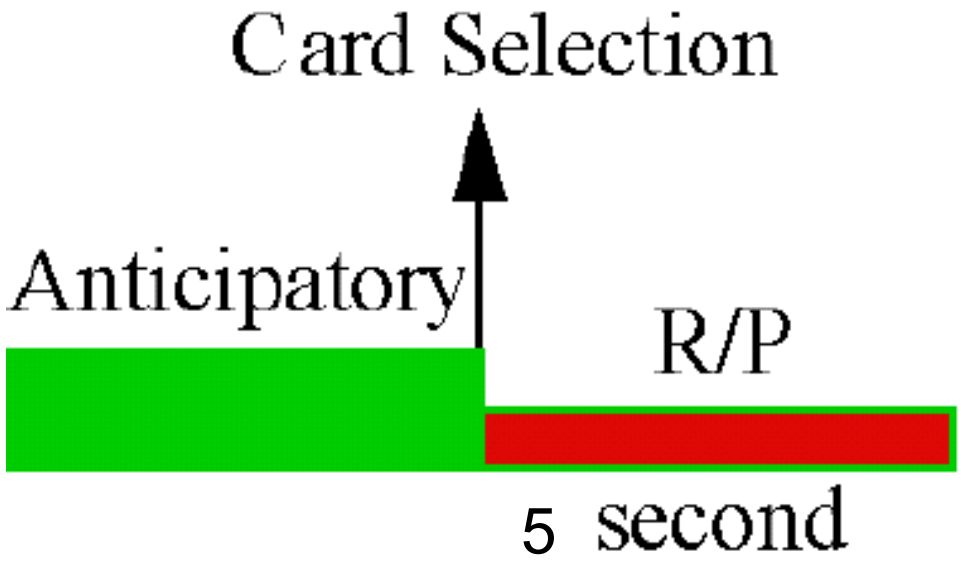
decks (***C*** and ***D***) yield lower immediate gain but a smaller future loss, i.e. a long term gain (advantageous decks).

Bechara et al. 1997

skin conductance responses

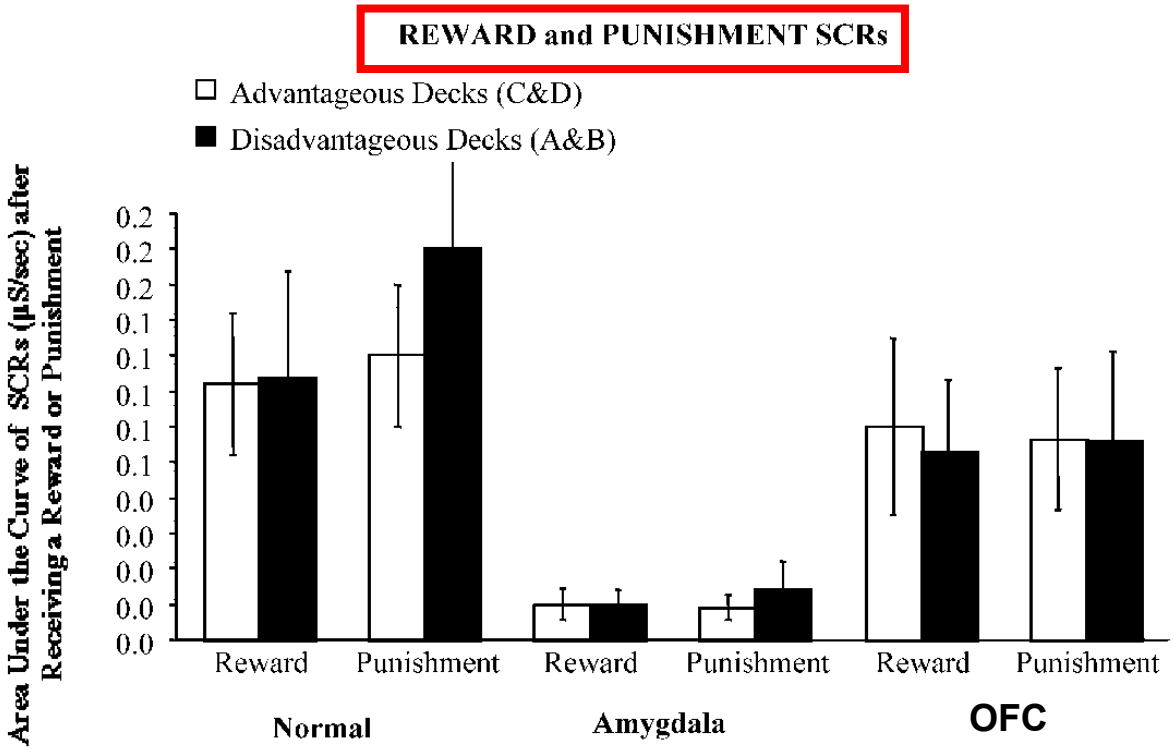


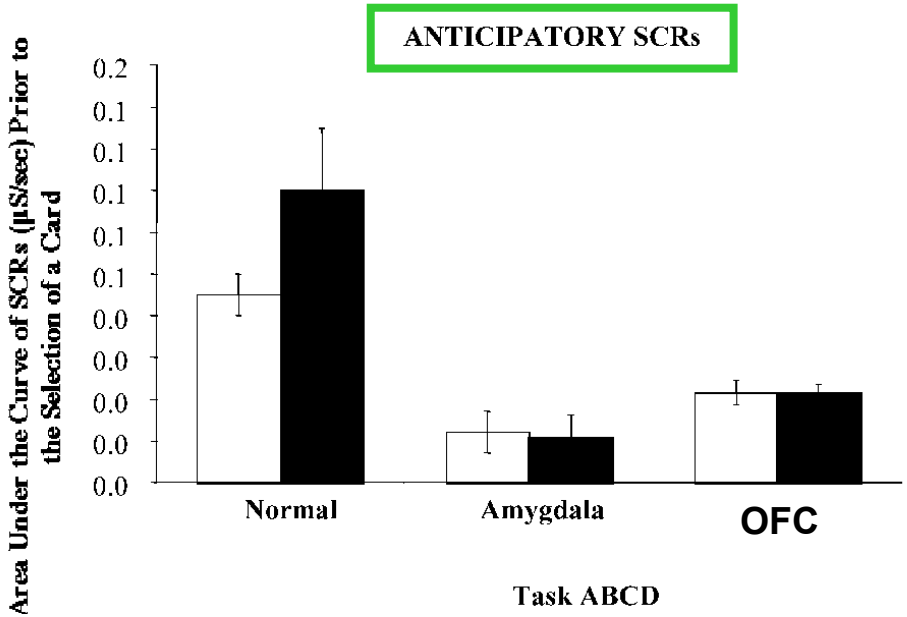
Combe & Naotaka Fujii 2011

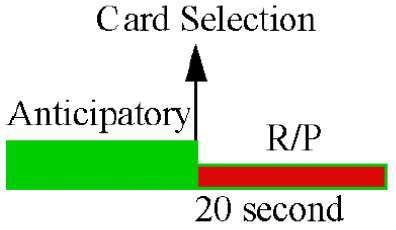


Anticipatory time window - the time during which the subject was pondering which card to select.

Reward/Punishment (R/P) time window - skin conductance responses (SCRs) generated in reaction to the outcome of winning or losing a certain amount of money.



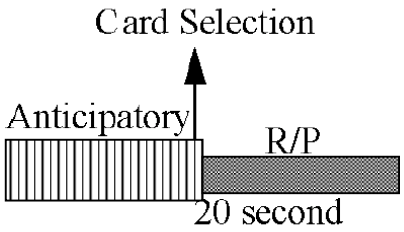




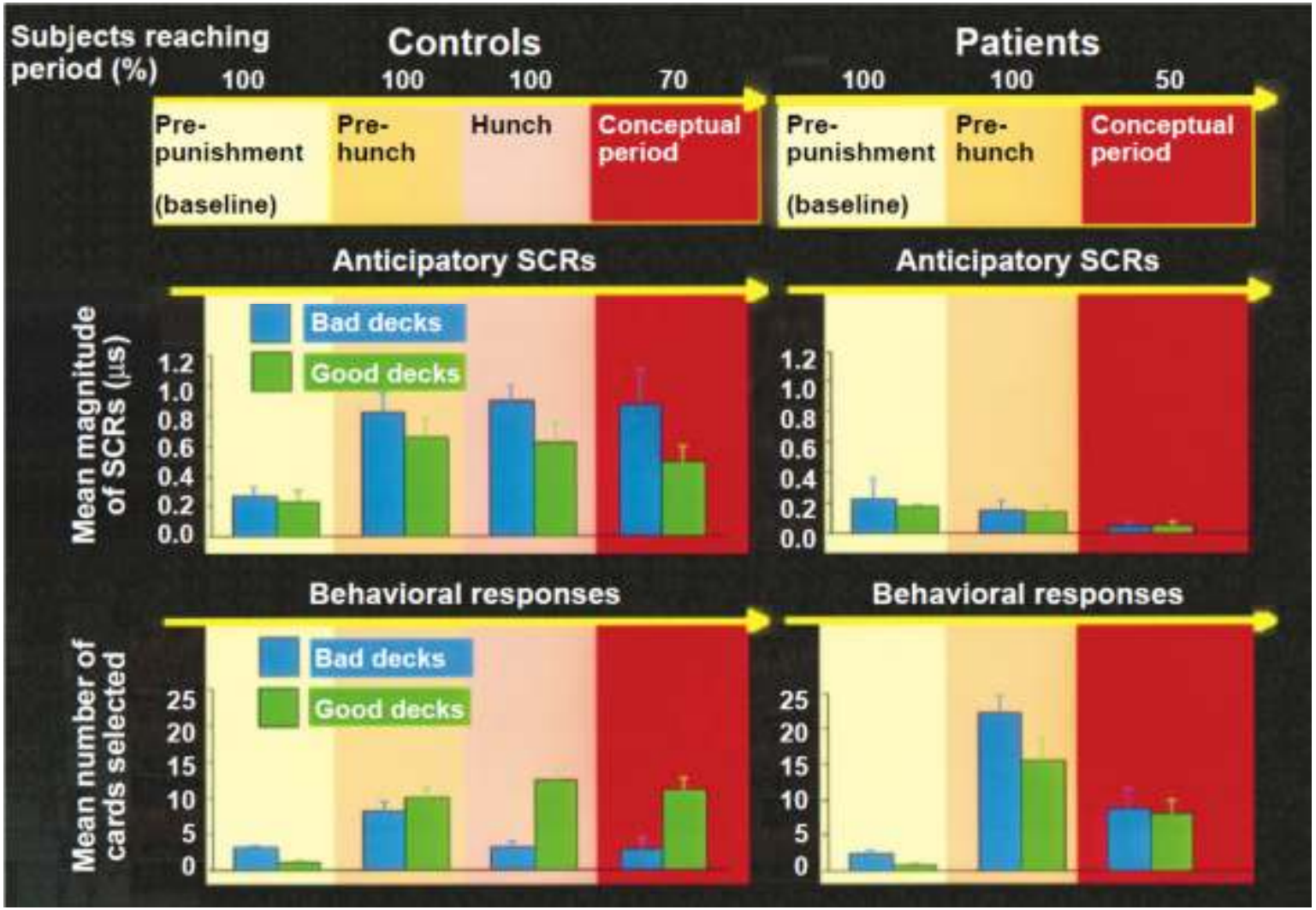
Bechara et al. 1997

Conscious knowledge alone is not sufficient for making advantageous decisions

- "**pre-punishment**" period, when subjects sampled the decks, before they had yet encountered any punishment.
- "**pre-hunch**" period, when subjects began to encounter punishment, but still had no clue about what was going on in the game.
- "**hunch**" period, when subjects began to express a hunch about which decks were riskier, but they were not certain.
- "**conceptual**" period, when subjects knew very well that there were good and bad decks, and which decks were good and bad.



OFC



Bechara et al. 1997

These results show

- VM patients continue to choose disadvantageous behavior in the gambling task, even after realizing the consequences of their action.
- Emotional biases of normal subject occur even before the subject becomes aware of the goodness or badness of the choice s/he is about to make.
- Knowledge may not be sufficient to ensure advantageous behavior.

Available online at www.sciencedirect.com

SCIENCE DIRECT®

Cognitive Brain Research 23 (2005) 85–92

COGNITIVE BRAIN RESEARCH

www.elsevier.com/locate/cogbrainres

Research report

The dark side of emotion in decision-making: When individuals with decreased emotional reactions make more advantageous decisions

Baba Shiv[a,*], George Loewenstein[b], Antoine Bechara[c]

[a]*Tippie College of Business, University of Iowa, Iowa City, IA 52242, USA*
[b]*Department of Social and Decision Sciences, Carnegie Mellon University, Pittsburgh, PA 15123, USA*
[c]*Department of Neurology, University of Iowa, Iowa City, IA 52242, USA*

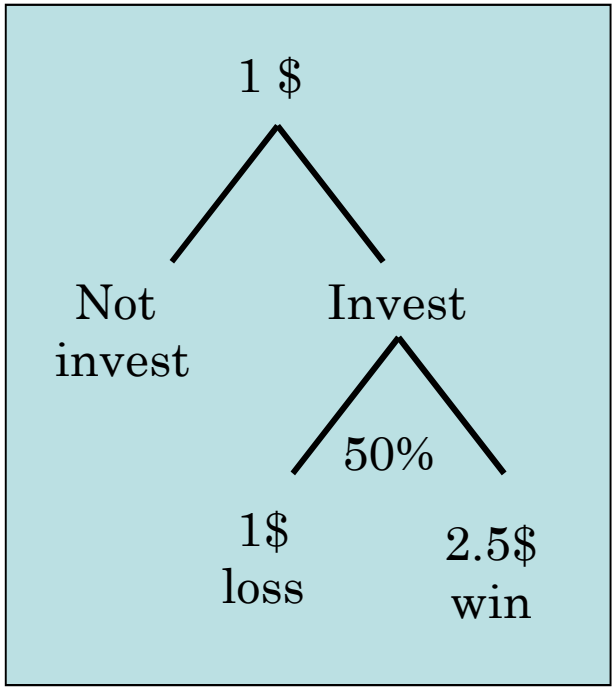
Accepted 5 January 2005
Available online 16 February 2005

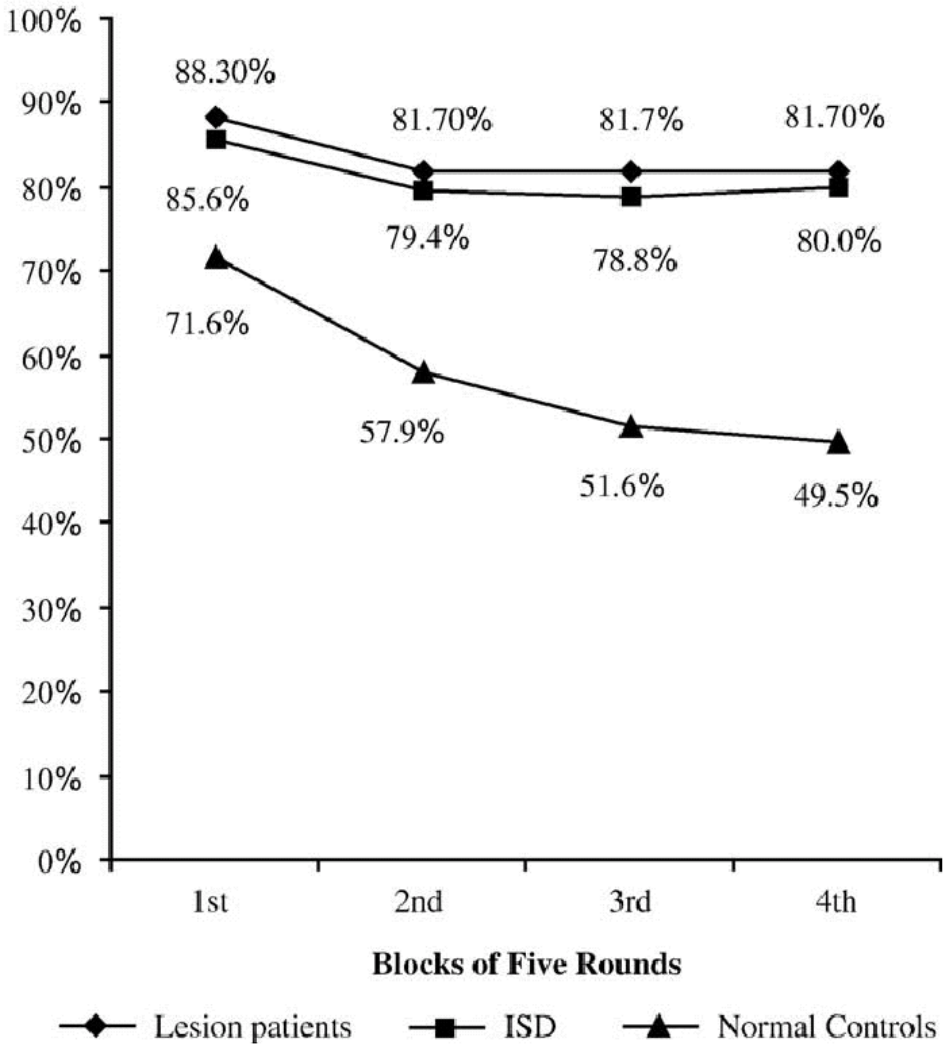
- Participants was endowed with $20
- Two options: invest $1 or not invest.
- Decision **not to invest** - subject keeps the dollar, and the task advance to the next round.
- Decision **to invest** - the experimenter tosses a coin:

  -heads (50% chance) - lose the $1 that was invested;

  -tails (50% chance) - $2.50 gain.

  The task would then advance to the next of 20 round.
- The expected value on each round is higher if one invests ($1.25) than if one does not ($1).





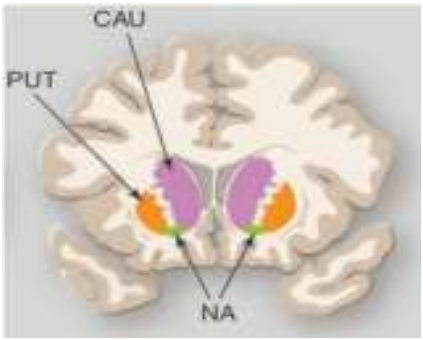
Mean percentage of rounds in which participants decided to invest $1. Normal participants start to withdraw from risk taking (investing) both after they lost on the previous round and when they won

(ISD - individuals with substance dependence)

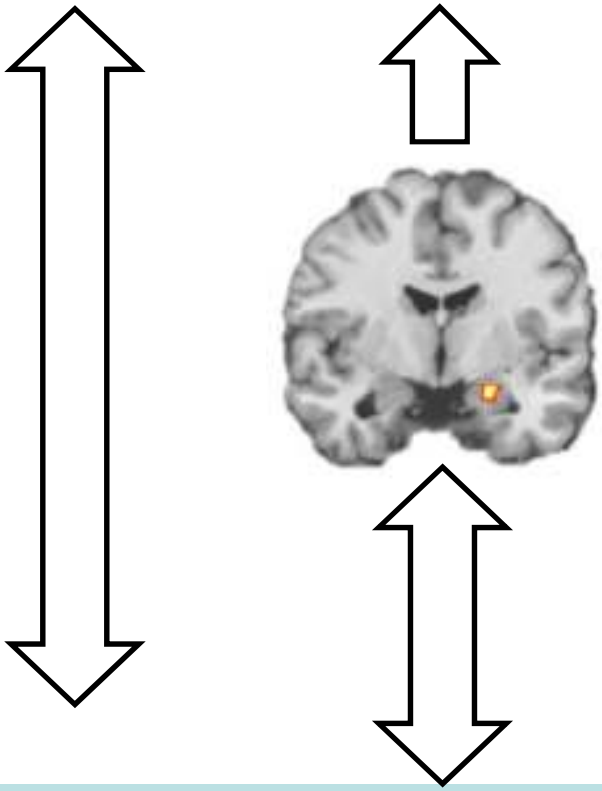
Shiv et al. 2005

Conclusions

- Emotional reactions to the outcomes on preceding rounds influence decisions of normal participants on subsequent rounds, so that they become conservative and risks aversive.
- In contrast, patients, abnormal in experiencing emotional reactions, were not influenced by the emotional reactions associated with the outcomes of preceding rounds, so that they were risks seeking.

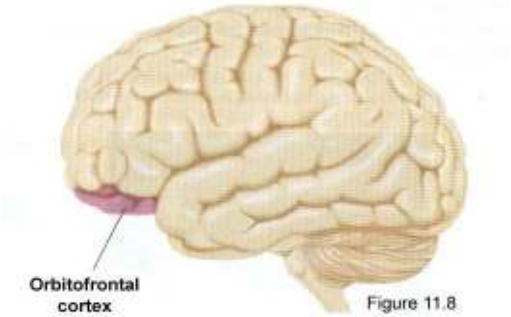


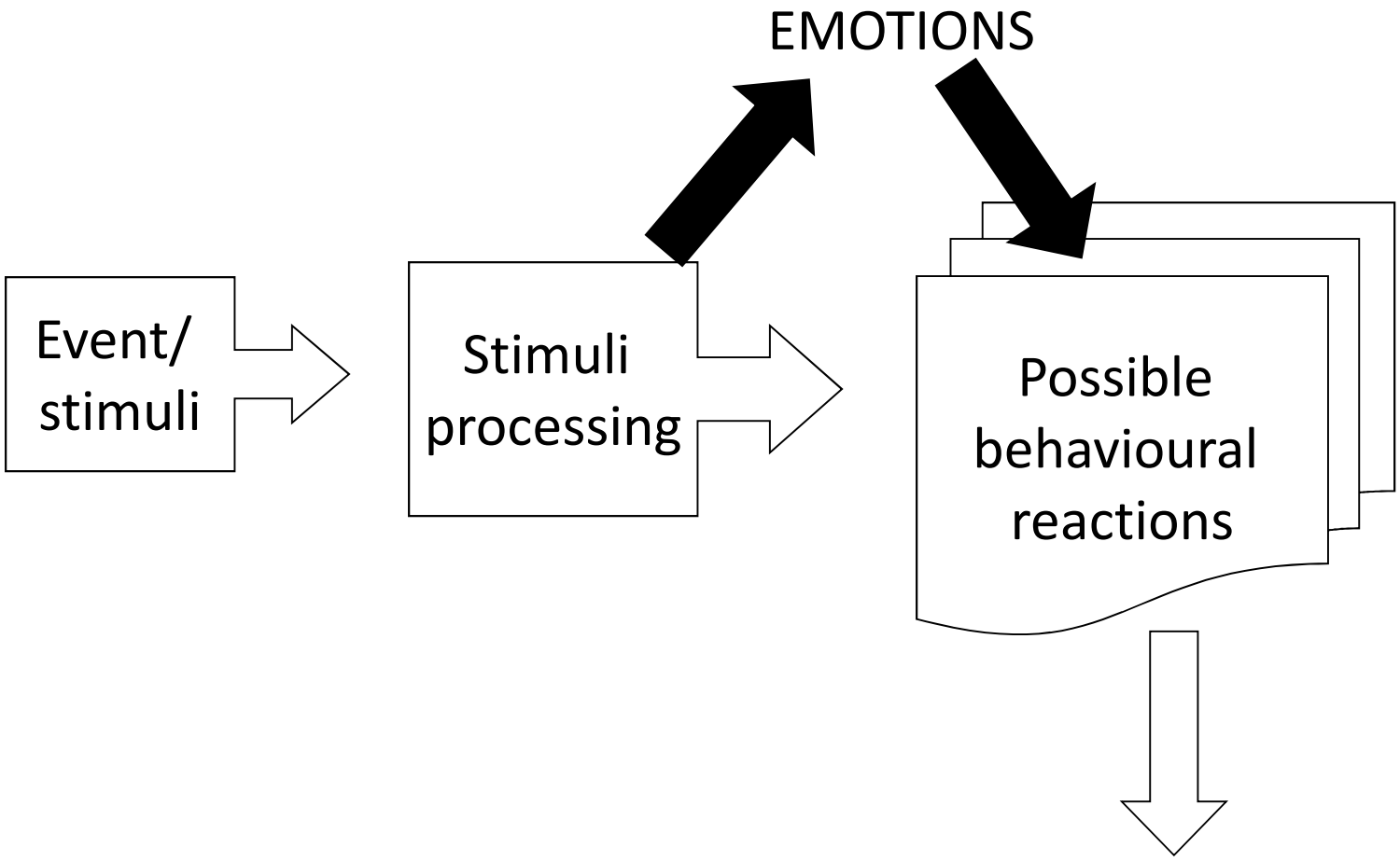
Nucleus accumbens (NAc) – subjective value / anticipated gain magnitude.



Amygdala – learning / costs analysis, fear.

Orbitofrontal cortex (OFC) – compares / integrates multiple information regarding the reward outcome, fast learning/





Emotions are heuristics

Take-home message?

Emotions matter…
to be continued.

Thank you for your attention!