NEUROMARKETING: IMPACT ON CONSUMER BEHAVIOUR

Author

Mr. Adheer Goyal, Dr. Mustafizul Haque, Dr. Parin Somani, Mr. S. MD Shakir Ali, Miss. Swati Parmar

HORIZON BOOKS

(A DIVISION OF IGNITED MINDS EDUTECH PVT LTD)

www.horizonbooks.asia

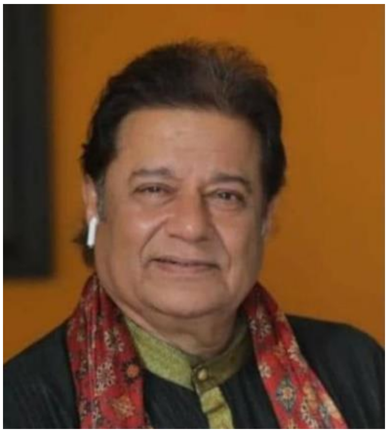
Disclaimer

The contents and context of this book are written by the author. Although every care has been taken to avoid errors and Omissions. This compendium is being published on the condition and understanding that the information given in this book is merely for reference and must not be taken having authority of binding way the author, editors or publisher.

ISBN- 000-00-00000-00-0

Printed and Published by:
HORIZON BOOKS
(A DIVISION OF IGNITED MINDS EDUTECH PVT LTD)
www.horizonbooks.asia

MRP: INR — 699/-



MOHAN NIVAS, 56, KELUSKAR ROAD, SHIVAJI PARK, MUMBAI - 400 028. • Ph. : 2445 3232 / 2446 1638
Email : anupjalota@gmail.com/anupjalotasemail@gmail.com • Website : www.anupjalota.in

01/07/2021

When we talk about Mahabharat , we find five different characters with special skills called The Pandwas. This book has five authors writing in their own style.
I'm sure readers will find it very interesting and informative.

All five authors are highly placed in their fields and have recognition globally.
Dr Parin Somani I know personally and very impressed with her knowledge.

Mr. Adheer Goyal ,Dr. Mustafizul Haque, Mohd. Shakir Ali, Miss Swati Parmar are also experts in the field of neuromarketing. I wish all five authors good luck and best wishes for success

Regards

Dedication Page

Mr. Adheer Goyal Dedicates this book

"To my late father, who told me the life-stories that always matter. To my mother, who taught me to inculcate them and remember for the betterment of the society as a whole."

Dr. Mustafizul Haque Dedicates this book

To my parents, without whom none of my success would be possible.

Dr. Parin Somani Dedicates this book

To my beautiful daughters and my family. They are my support system and inspiration to fulfil my life's motto: To serve mankind until my last breath. "Life possess true meaning when dedicated to the service of others. By working together, we can make positive global change."

Mr. Shakir Ali Dedicates this book

To My loving father, who though dwells in paradise, is always with me Late Mr. Md Ali Asghar. His strength and great dreams for me keep going in life. His blessings protect me.

Also, dedicated to my mother, Teachers & Family Members. They understand me, and always held me by my hand and showed me the way whose compassion.

Miss. Swati Parmar Dedicates this book

To her Parents, family and colleagues for constant encouragement and motivation

About the Author

Mr. Adheer Goyal

Mr. Adheer Goyal, Research Scholar and Dean Admission, School of Commerce & Management, G H RAISONI UNIVERSITY SAIKHEDA (M.P). Currently pursuing Ph.D. in Marketing from G H RAISONI University, Saikheda (M.P). He obtained B.com (2008) from Nagpur University, P.G.D.B.M (2010) from WINTEC, New-Zealand. MBA (2015) from Nagpur University, and M. Com (2020) also from Nagpur University

Mr. GOYAL has served as Controller of Examination and HOD of Commerce & Management in College affiliated to SNDT University. He was Coordinator of NAAC committee and In-Charge of Admissions.

Mr. GOYAL's teaching and research interest include International Marketing, Business Law, Strategic Management, and International Business. He has contributed more than 20 Scopus Index, National, International journals, Conferences, Seminars. He has two patents granted on his name (Forecasting Management Information system and Internet of things (IOT) based defined digital marketing strategies, approaches with unique result using AI-Based programming)

He has published two books on the topic Digital Marketing – Critical Platform for Brand Management and covid management.

About the Author

Dr. Mustafizul Haque

Dr. MUSTAFIZUL HAQUE, Dean & Associate Professor School of Commerce & Management G.H. RAISONI UNIVERSITY SAIKHEDA (M.P). He obtain B.com (2008) from Patna University, Patna, M.B.A (2010) from G.B.T.U, Lucknow, and his Doctoral Degree in (2015) Faculty of Management from B.R.A.B.U Muzaffarpur, Bihar. Professor HAQUE has served as faculty member such as M.S college, Motihari; I.T.M., Aligarh; and Aurora PG College(MBA) ,Hyderabad. While at Aurora PG College(MBA), Hyderabad he was member of NAAC committee and co-ordinator of III Cell. He is served as editorial board of member various Journals like SAARC, Anvikshiki and UGC care list. Organized workshop, National & International conference & Seminar at University level. He is also appointed as P.hD supervisor in G H Raisoni University.

He has contributed more than 40 Scopus Index, National, International journals, Conferences, Seminars, FDP, MOUs and successfully has two patents granted (Forecasting Management Information system and Internet of things (IOT) based defined digital marketing strategies , approaches with unique result using AI-Based programming). Four Text Book Published (Essentials of Management, Business Ethics, Digital Marketing – Critical Platform for Brand Management and book on covid management).

About the Author

Dr. Parin Somani

Dr. Parin Somani is an Independent Academic Scholar, Educator, International Motivational Speaker, Author, Writer, Humanitarian and Philanthropist. She holds Five Doctorate degrees and Four World Book of Records Achievements including the 'Thickest book in the world.' She has delivered 184+ sessions at various scholar faculties within universities, international conferences, Governmental and NGO's during the COVID-19 pandemic, presenting her research, building bridges between international societies. Dr Parin Somani has travelled: 87+ countries globally making positive global change. Published 47+ educational papers, books, newspapers and magazine articles. Featured in 70+ videos, 132+ newspapers and books for her remarkable societal contribution.

Dr Parin Somani is: Academic Scholar for various international universities. She is Editorial Board Member of the Journal of Artificial Intelligence and Big Data; Editorial Board Member of Pragma Journal of Woman Health, Safety and Empowerment. Dr Parin Somani is also a Multi-International Award Winner.

She also has one patent granted on her name (Internet of things (IOT) based defined digital marketing strategies, approaches with unique result using AI-Based programming).

About the Author

Mr. S. MD Shakir Ali

Mr. S. MD SHAKIR ALI, Currently Founder & CEO of Digitize Consulting Services LLP; a blend of Academia & Industry and Being Digital Serial Entrepreneur, Lately Awarded - Global Quality Awards for Quality Education & Digital Marketing Services"50 Best Digital Marketing Professionals of India" award at Mobile & Digital Marketing Summit "More than a Two decades of experience in Digital Marketing Services consultant and business owner. He is engaged as trainer for SMEs – Hyderabad chapter for entrepreneurs to capitalize Internet for their respective business.

Awarded By:

- National award for Eminent Educationist by Indo-American (Indus) Foundation for Digital Marketing
- Digital Marketing Man of the Year by AICC
- Best Digital Marketing Services provider in Andhra Pradesh by Brands Academy

He was associated with few of business schools in India like WLCI; Ni-MSME (Govt of India for Skill Development for entrepreneurs), MANUU, SSIM – Hyderabad; and many more.

He has published book (Digital Media–Critical Platform for brand management) and He has two patents granted on his name (Forecasting Management Information system and Internet of things (IOT) based defined digital marketing strategies, approaches with unique result using AI-Based programming)

About the Author

Miss. Swati Parmar

Miss. Swati Parmar, Assistant Professor, School of Commerce & Management, G. H. RAISONI UNIVERSITY SAIKHEDA (M.P). She obtained B.Tech in Chemical Technology from Laxminarayan Institute of Technology, Nagpur (RTMNU) in 2011 and MBA (Finance & Operation) from Dr.Babasaheb Ambedkar Institute of Management Studies & Research, Nagpur (RTMNU) in 2015.

Miss. Parmar also worked as an assistant professor for one year in Prerna Junior College of Commerce & Science in nagpur and as a technical support engineer for two years in a German based company.

Miss. Parmar has two patents granted on her name (Forecasting Management Information system and Internet of things (IOT) based defined digital marketing strategies, approaches with unique result using AI-Based programming).

Table of Contents

Chapter 1

EXPLORING THE BRAIN

1.1 FUNCTIONS OF THE NERVOUS SYSTEM

The nervous system provides environmental information and generates reactions to the information around us (sensation) (motor responses). The nervous system may be split into sensational (sensory) and response-responsive sections (motor functions). However, there is a third function to include. Sensory information must be incorporated into other sensations, memories, emotional conditions or learning (cognition). Some parts of the nervous system are called areas of integration or association. The integration process combines sensory impressions and higher cognitive processes including memory, learning and emotion to generate a reaction.

Sensation

The nervous system's first important role is sensing—to receive environmental information to acquire knowledge about what happens outside the organism (or, sometimes, within the body). The nervous system's sensory processes record a shift from homeostasis or a specific occurrence, which is called a stimulus.

The "big five" are the meanings we most think of: taste, smell, feel, sight and listening. Both chemical substances (molecules, compounds, ions, etc.), touch are stimuli for taste and smell; they are physical or mechanical stimuli that interact with the skin; vision are light stimuli; and hearing is sound perception, an incentive of some kind. There are certainly additional senses, but the list is the main meanings. All of these five senses are stimulating from the outside environment and are aware of. Additional sensory inputs may come from inside the body, such as the stretch of a wall of the organ or the blood content of specific ions.

Response

The neurological system reacts on the basis of sensory structure-perceived inputs. The movement of muscles, such removing the hand from a hot stove, would be an obvious reaction, but wider applications of the word exist. The nervous system may induce all three muscular tissue types to contract. For instance, skeletal muscle contractions for moving the skeleton, heart muscle influences increases in activity, and the digestive system pushes food through the digestive tract, smooth muscular contractions. Response also includes brain control of glands in the body such as eccrine and merocratic sweat glands that are in the skin to low body temperature, such as sweat production and section.

Answers are split into those who are willing or aware (skeletal muscle contraction) and those who are unintended (contraction of smooth muscles, regulation of cardiac muscle, activation of glands). Somatic nervous system regulates voluntary responses and autonomous nervous system involuntary reactions, which is described in the next section.

Integration

In the neurological system where this information is processed, stimuli that are received via sensory structures are sent. That's what integration is called. Stimules are compared to other stimuli, prior stimuli or the condition of a specific individual at a certain moment, or incorporated into them. This leads to the particular reaction to be produced. The batter does not automatically swing when a baseball is thrown to a batter. It is important to examine the trajectory of the ball and its speed. Perhaps the count is three balls and a strike and the hitter wants that pitch to pass in the aim of reaching the first base. Or maybe it would be enjoyable simply to watch the batter's team is so far ahead.

Controlling the Body

Mostly based on functional difference in reactions, the nervous system is split into two sections. A conscious perception and voluntary motor responses is the responsibility of the somatic nerve system (SNS). Voluntary engine reaction implies skeletal muscle contraction but such contractions are not always voluntary to the extent that you wish them to be carried out. Some somatic motor responses are reflexes and frequently occur without a deliberate choice. You will be shaken and may exclaim or jump back if your buddy leaps out from behind a corner and shouts "Boo!" You didn't make that decision and you probably didn't intend to offer your girlfriend a cause to chuckle, but it's a reflection of skeletal muscle contractions. Other motor reactions become automatic (i.e. unconscious) when a person acquires motor abilities ("habit acquisition").

The autonomous nerve system (ANS) has unintentional bodily control, typically for homeostasis (regulation of the internal environment). The autonomous function sensory input may range from external or external environment stimuli to sensory structures. The engine output reaches smooth muscle, heart and glandular tissue. The autonomous system has a function to play in regulating organ systems inside the body, which typically govern homeostasis. The autonomous system, for example, controls sweat glands. Sweating helps cool your body when you're overheated. The mechanism is homeostatic. But you may also start to sweat if you're anxious. It's not homeostatic, it's an emotional physiological reaction.

The nervous system has another division which defines functional reactions. The enteric nervous system (ENS) controls your digestion system for smooth muscle and glandular tissue. It is an important component of the PNS and does not rely on the CNS. However, enteric systems are sometimes considered as part of an autonomic system since neuronal structures that make up the enteric system are part of the autonomous digestive output. There are significant variances, but there will be a fair overlap for our needs here. for instance, when such nervous system divisions may be discovered.

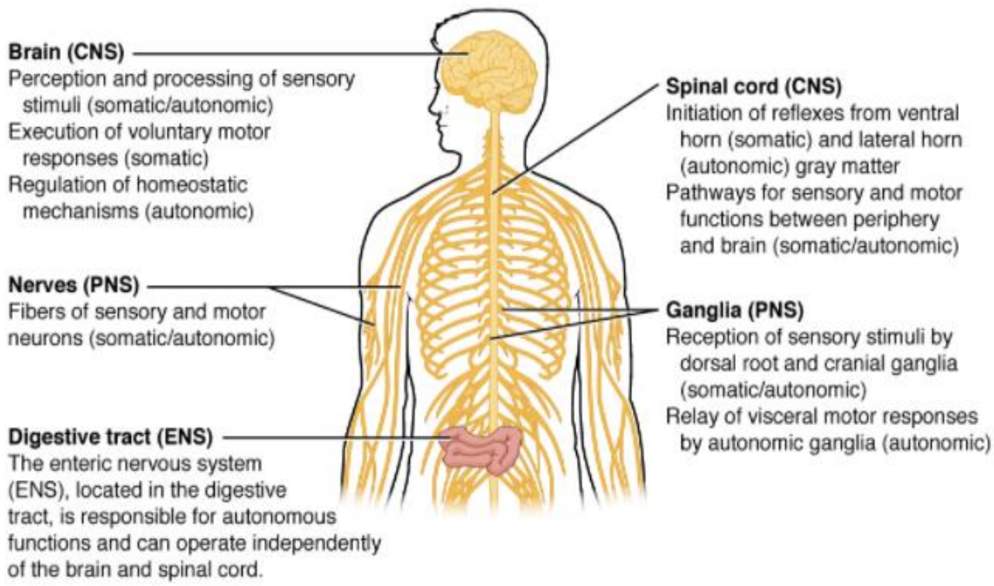


Figure 1.1: Somatic, Autonomic, and Enteric Structures of the Nervous System

1.2 PERIPHERAL NERVOUS SYSTEM

The peripheral nervous system is referred to outside of the brain and spinal cord. It contains the cranial nerves, spinal nerves and their root and branch, neuromuscular junctions and peripheral nerves. The anterior horn cells are often discussed alongside the peripheral nervous system since they are part of the motor system, but they are officially part of the central nervous system (CNS).

Bundles of sensory neurons or axons lead to and from the central nervous system in the peripheral nervous system. The autonomous nervous system is part of the nervous system that is responsible for the incorporation of unintentional structures such as the heart, smooth muscles and glasses in the body. It is spread throughout the central and peripheral nervous systems.

1.3 CENTRAL NERVOUS SYSTEM (CNS)

The brain and spinal cord are the central nervous system. It is called "central" because it integrates information from the whole organism and controls action across the entire organism.

The brain and spinal cord are part of the CNS.

The brain is protected by the cranial cavity, the back of the brain and down into the middle of the spine, which stops at the lower back lumbar area.

Both the brain and spinal cord are contained inside a protection membrane known as meninges.

Anatomists and physiologists researched extensively the central nervous system, but it still contains a lot of mysteries and governs our thoughts, actions, emotions and desires. The respiration, the heart rate, the release of certain hormones, the body temperature and more are also controlled.

The retina, optic nerves and olfactory nerves together with the cerebral and spinal cord are sometimes regarded as a component of the CNS. This is because they are connected directly without intermediary nerve fibres to the brain tissue.

A 3D map of the CMS is given below. To interact and examine the model, click on it.

Figure 1.2: Central Nervous System

The brain

The brain is the most complicated organ in the human body; it includes an estimated 15–33 billion neurons, each linked to hundreds of other neurons, in the outermost portion of the brain and biggest part per volume.

The human brain comprises a total of about 100 milliards of neurons and 1,000 billion glial (support) cells. About 20% of our entire bodily energy is used in our brain.

The brain is an activity-coordinating core bodily control module. From physical movement to hormone release, memory formation and feeling of emotion.

Some regions of the brain have specific responsibilities to perform these tasks. Many higher functions – thinking, problem-solving, creativity – require many fields of networking.

Spinal cord

With the spinal cord nearly the whole length of the back, information is sent between the brain and body, but other activities also take place.

31 spinal nerves enter the cord from the brainstem where the spinal cord joins the brain.

It links to the nerves of the nervous system in the periphery, which run through the skin, muscles and articulations along its length.

Motor instructions of the brain from the spine to the muscles and sensory information goes to the spinal cord from the sensory tissues — such the skin — and then up to the brain.

The spinal cord has a number of circuits, such as the unintended movement of the arm if the finger touches a fire.

1.4 ANATOMY AND THE FUNCTIONAL STRUCTURE OF THE BRAIN

The brain is a wonderful three-pound organ which regulates all processes of the body, analyses outside-world information and encompasses the essence of the mind and the soul. Intelligence, creativity, emotion and memory are some of the many things that the brain controls. The cerebrum, cerebellum and brainstem are protected inside the skull.

In our five senses the brain gets information: vision, smell, touch, taste and listening – often numerous. It compiles the messages and may store them in our memory and have a significance for us. The brain regulates our thoughts, our memories and our voice, our arms and legs movement and the operation of numerous organs in the body.

The central nervous system (CNS) consists of the brain and backbone. The peripheral nervous system (PNS) consists of the spinal nerves that are connected with the spinal cord and the cranial nerves that are connected to the brain.

Cells of the brain

The brain consists of two cell types: neuronal cells and glia cells..

Nerve cells

There are various neuron sizes and forms but all are cellular, dendrites and axons. The neuron transmits electrical and chemical impulses for information. Try to imagine your house with electric wiring. There are many wires connected to one electrical circuit in a manner that a light bulb may be activated when a light switch is activated. An activated neuron transmits its energy to neurons in its surroundings.

Neurons pass to one other via a small gap called a synapse, their energy or "speak." A neuron contains numerous branches called dendrites that function like antennas that collect signals from nearby cells of the nerve. The cell body passes these messages to decide if the message must be sent. Significant signals are sent to the end of the axon, when neurotransmitter sacks are opened at a synapse. The molecules of the neurotransmitter are sent across the synapse and fit into specific receptors on the receiving nerve cell.

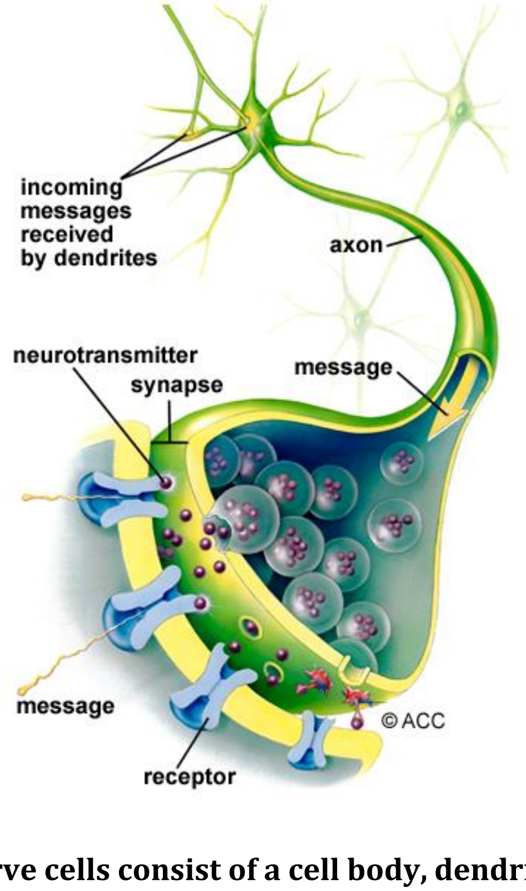


Figure 1.3: Nerve cells consist of a cell body, dendrites and axon. Neurons communicate with each other by exchanging neurotransmitters across a tiny gap called a synapse.

Glia cells

Glia is the cells of the brain that give nutrition, protection and structural support for the neurons. The cells that are the most frequent kind of cells implicated in brain tumors are about 10-50 times glia.

- Astroglia or astrocytes are the caretakers — they regulate the blood brain barrier, allowing nutrients and molecules to interact with neurons. They control homeostasis, neuronal defence and repair, scar formation, and also affect electrical impulses.

- Oligodendroglia cells create a fatty substance called myelin that insulates axons – allowing electrical messages to travel faster.

- Ependymal cells line the ventricles and secrete cerebrospinal fluid (CSF).

- Microglia are the brain's immune cells, protecting it from invaders and cleaning up debris. They also prune synapses.

1.4.1 The Cerebrum

The biggest portion of the brain is the brain, sometimes called the forebrain. It comes from the telencephalon embryologically. The brain comprises two cerebral hemispheres (right and left) that include the corpus callosum, divided by a deep longitudinal crack. It is wrapped with thin, but protecting membranes, names meninges, one of which is filled with brain fluid in the subarachnoid area.

You will note that it is not completely smooth if you ever saw a photograph or plastic model of a human brain. The brain is instead filled with grooves and ridges in all directions. These are correspondingly known as sulci and gyri. Their function is to expand the surface area of the cerebrum and therefore the number of neurons. This allows increased processing and cognitive skills in the brain hemisphere.

Each cerebral hemisphere is composed of five lobes:

- Frontal

- Parietal

- Temporal

- Occipital

- Insular

Frontal lobe

The lobe of the front is the earliest portion of the brain. It participates in processes such as muscular control, intellectual development, personality, emotion, social behaviors and language. The frontal lobe is then divided by a central sulcus (from the Rolando) from the parietal lobe and by the lateral sulcus from the temporal lobe (of Sylvius). The precentral, the superior, the medium, the lower and orbital gyri are the most important convolutions of the frontal lobe. The whole frontal lobe is fed by anterior and middle brain arteries, the internal carotid artery branches.

Figure 1.4: Cerebrum

Parietal lobe

The parietal lobe is located between the frontal and occipital lobes and the central and part-occipital sulcus are isolated from one other. It contributes both to the language and calculation and the experience of different feelings, such as touch, pain and pressure. The lobe is made of two components, the lobules (upper and lower) and an intraparietal sulcus. The postcentral sulcus with the postcentral, angular and super marginal gyri constitutes further significant markers. Branches from the front, middle and posterior brain arteries supply the parietal lobe. The latter comes from the basil artery.

Temporal lobe

We've got an additional region of the brain called the temporal lobe following down the list. It has memory, speech and hearing. It is responsible. It stands below the two preceding lobes, from which the lateral sulcus is detached. The temporal lobe is made up of the upper, middle- and lower-time gyri bounded by the lower and upper sulci. The central and rear cerebral arteries are supplied.

Occipital lobe

The occipital lobe is the back part of the brain and is involved in visual stimulation. It sits on the cerebellar tentorium fold, a pliant of dura mater which separates it from the brain. By the partite-occipital sulcus and by the worrying notch, the occipital lobe is isolated from the parietals and temporal lobes. The upper and lower occipital gyri (separated by the lateral occipital sulcus), the lingual gyrus and the cuneus are other significant structures and landmarks. The occipital lobe's circulatory supply comes from the back of the brain artery.

Insula

We have the insula or insular lobe below the frontal, parietal, and temporal lobes. This lobe is used to treat many senses, including taste, visceral discomfort and vestibular function. The insula's central sulcus separates it into short and long gyri. The branches of the main brain artery supply this lobe.

The limbic lobe which modulates visceral, hormonal, autonomic and emotional processes, learning and memory is the ultimate, physical structure visible on the sagittal view of the brain. In fact, the limbic lobe is wrong since it is regarded a region of the brain instead of a lobe. It comprises of a subcallosal, cingulate and par hippocampal gyri, and hippocampal formation, superior to the corpus callosum (a subcortical structure).

1.4.2 The Hemispheres

The brain is the vital organ of the central nervous system. It is a complex organ consist of billions of interconnected neurons and glia. The brain has two sides and separated into unique lobes. Each lobe has a specific set of functions.

Although the brain is a complex organ – a hardworking one with a hundred billion neurons, it surprisingly weighs only three pounds. It makes up around 2% of the human weight and only takes up about 20% of the body’s total energy.

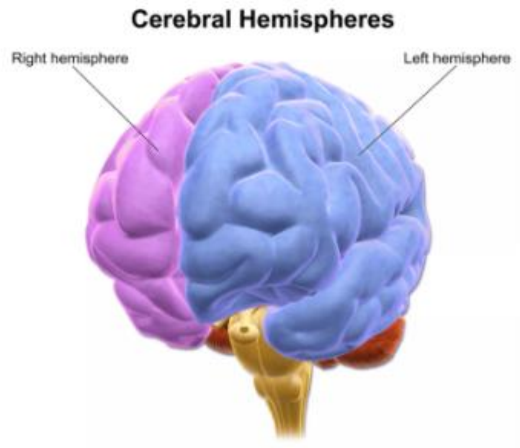


Figure 1.5: Hemispheres

The brain, a complex organ, has several functions. It is a complex organ. The two sides of the brain interact to carry out all essential physical procedures. The left and the right side of the brain appear remarkably similar yet share some distinctions, particularly in information processing.

Some kinds of impairment may arise from a lack of integration among the various components of the brain.

The human brain can identify itself. It is capable of learning and adapting to change. The functions of each side of the brain influence the capacity of the individual to learn and accommodate.

Left Brain and Right Brain Theory

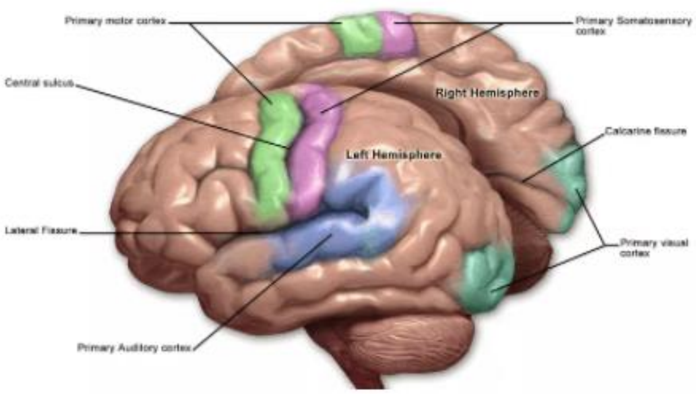


Figure 1.6: Left Brain and Right Brain

A person may be brained on the right or on the left. It implies there is a dominant side of the brain. Methodical and analytical in character are the left-brained dominants. Those that have the right brain are creative and artistic.

In the 1960s, a psychologist called Roger W. Sperry developed the left brain and right brain hypothesis.

The Left Hemisphere of the Brain

The right part of the brain governs the right part of the body. The individual is rational and more academically inclining when the left part of the brain is dominant.

Figure 1.7: Left Hemisphere of the Brain

You most likely excel in academics, especially math and science. The left hemisphere of the brain is also called the digital brain. It is the one responsible for the following:

- Verbal
- Analytical
- Order
- Reading

- Writing
- Computations
- Sequencing
- Logic
- Mathematics
- Thinking in words
- Linear thinking
- Visual based languages such as in mute and deaf people

Left hemisphere dominant people usually excel in the following fields:

- Business analyst
- Programmer
- Reporter
- Scientist
- Network administrator

Detailed information about the functions and characteristics of the left brain.

- It has the ability to understand the sum of any situation/look at things from.
- It involves the movement of large muscles such as walking.
- It plays an important role in maintaining balance.
- It is responsible for non-verbal communications.
- It can sense smell, taste, and sound.
- It is responsible for emotional functions.
- It regulates avoidance behaviour.

- It controls the immune system.
- It is in charge of involuntary body functions like digestion, the beating of the heart, and breathing.
- It is stimulated by new experiences.
- It affects the person's ability to pay attention to details.
- Fine motor skills.
- Convert sounds to language and translates meaning.

The Right Hemisphere of the Brain

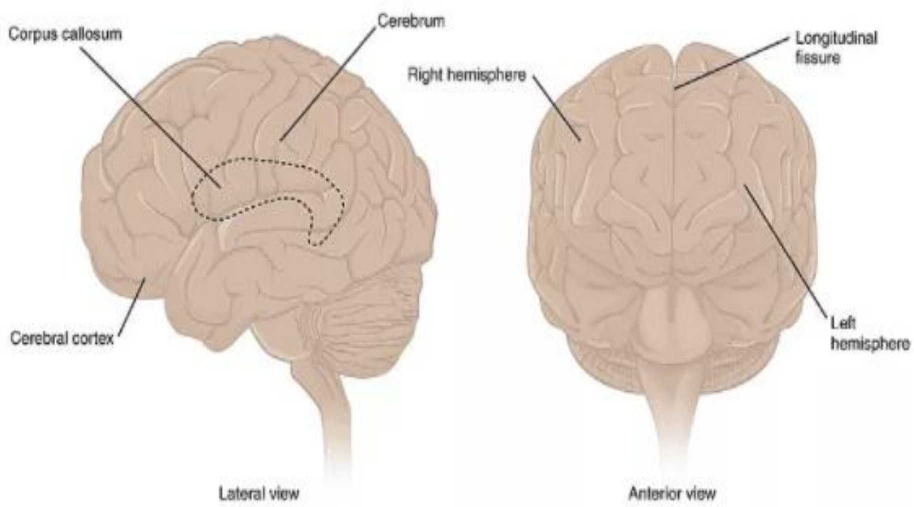


Figure 1.8: Right Hemisphere of the Brain

The right side of the brain controls the left side of the body. A right hemisphere dominant person excels in arts. It is visual and intuitive. It is also called the analog brain. It is responsible for the following:

- Creativity
- Imagination
- Intuition
- Holistic thinking

- Arts
- Feeling's visualization
- Non-verbal cues
- Rhythm
- Daydreaming
- Emotions

Right hemisphere dominant people usually excel in the following fields:

- Graphic design
- Interior designer
- Musician
- Painter
- Psychologist
- Counsellor
- Manager

Detailed Information about the Functions and Characteristics of the Right Brain

- It allows young children to grasp and understand the concept of more versus less.
- The right hemisphere of the brain is responsible for some of the cognitive functions such as attention, processing of visual shapes and patterns, emotions, verbal ambiguity, and implied meanings.
- Children below 3 years old are predominantly governed by the right brain.

1.4.3 Limbic System

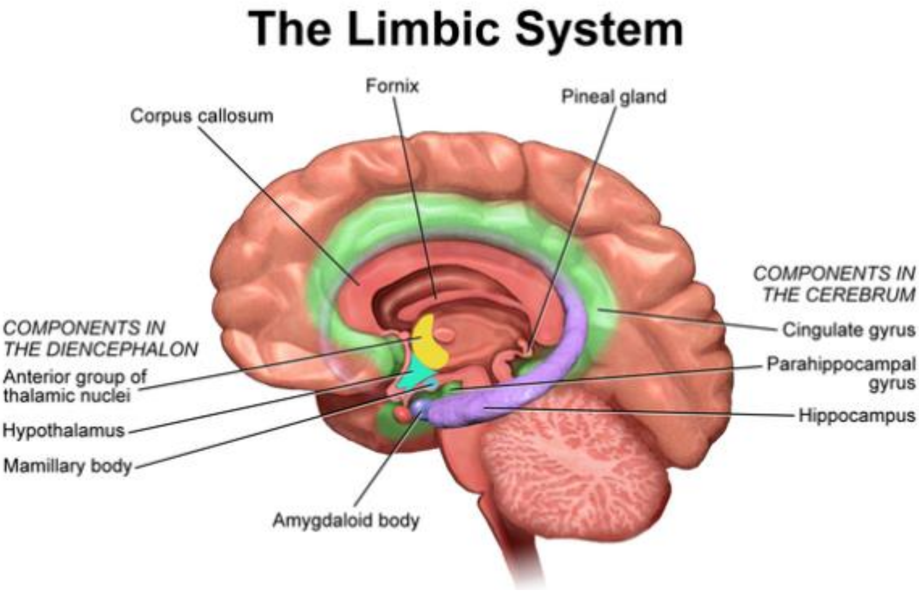


Figure 1.9: Limbic System

The limbic system is a set of structures of the brain. These structures cover both sides of the thalamus, right under the cerebrum. It is not a separate system, but a collection of structures from the cerebrum, diencephalon, and midbrain. It supports many different functions, including emotion, behavior, motivation, long-term memory, and olfaction. It is the part of the brain involved when it comes to behaviors we need for survival: feeding, reproduction and caring for our young, and fight or flight responses.

- It combines higher mental functions and primitive emotion into a single system often referred to as the emotional nervous system. It is not only responsible for our emotional lives but also our higher mental functions, such as learning and formation of memories. The limbic system is the reason that some physical things eg eating, seem so pleasurable to us, and the reason why some medical conditions, such as hypertension, are caused by mental stress.

- There are several important structures within the limbic system: the amygdala, hippocampus, thalamus, hypothalamus, basal ganglia, and cingulate gyrus.[2]

- The limbic system is among the oldest parts of the brain in evolutionary terms: it can be found in fish, amphibians, reptiles and mammals.

- The pleasure center is located in the limbic system. It is involved in sexual arousal and in the "high" derived from certain recreational drugs.

Limbic System Disorders

Because subparts of the limbic system ultimately regulate important aspects of our conscious and unconscious patterns (including our emotions, perceptions, relationships, behaviors and motor control) it’s easy to see why damage to this region can cause serious problems.

Disorders or behaviors that are related to limbic system dysfunction/damage (eg traumatic injuries or aging) include:

- Disinhibited behavior: Person doesn’t consider the risk of behaviors and ignores social conventions/rules.
- Increased anger and violence: Commonly tied to amygdala damage.
- Hyperarousal: Amygdala damage, or damage to parts of the brain connected to the amygdala, can cause increased fear and anxiety. Anxiety disorders are sometimes treated with drugs that target areas of the amygdala to decrease fear-based emotions.
- Hypoarousal: Can cause low energy or lack of drive and motivation.
- Hyperorality/Kluver-Bucy Syndrome: This is characterized by amygdala damage that can lead to increased drive for pleasure, hypersexuality, disinhibited behavior and insertion of inappropriate objects in the mouth.
- Appetite dysregulation: Destructive behaviors tied to hyperorality or thalamus dysfunction can include overeating, binge eating or emotional eating.
- Trouble forming memories: Hippocampal damage can include short-term or long-term memory loss. Learning is often greatly impacted by hippocampal damage, since it depends on memory.
- Cognitive disorders eg Alzheimer’s disease: Research shows that

people with Alzheimer's and memory loss usually have experienced damage to the hippocampus. This causes memory loss, disorientation and changes in moods. Some of the ways that the hippocampus can become damaged include free radical damage/oxidative stress, oxygen starvation (hypoxia), strokes or seizures/epilepsy.

1.5 CEREBELLUM

The brain collects information from the sensory system, the spinal cord and other brain components and controls motor movements. The cerebellum co-ordinates the movement of the body voluntarily, such posture, balance, coordination and speech.

It is a very tiny proportion of the brain—about 10 percent of the overall weight, but it includes around half of the brain's neurons, connective tissue that conduct electricity.

The brain is not human-only. It's an older part of the brain, evolutionarily speaking. Scientists think it existed before humans in animals.

Damage to the brain may lead to loss of balance, slower movements and tremors, but not to paralysis or intellectual disability (shaking). Complex bodily activities would be unstable and stopped.

Anatomical Structure and Divisions

The cerebellum consists of two hemispheres which are connected by the vermis, a narrow midline area. Like other structures in the central nervous system, the cerebellum consists of grey matter and white matter:

- **Grey matter** – located on the surface of the cerebellum. It is tightly folded, forming the cerebellar cortex.

- **White matter** – located underneath the cerebellar cortex. Embedded in the white matter are the four cerebellar nuclei (the dentate, emboliform, globose, and fastigi nuclei).

There are three ways that the cerebellum can be subdivided – anatomical lobes, zones and functional divisions

Anatomical Lobes

There are three anatomical lobes that can be distinguished in the cerebellum; the anterior lobe, the posterior lobe and the flocculonodular lobe. These lobes are divided by two fissures – the primary fissure and posterolateral fissure.

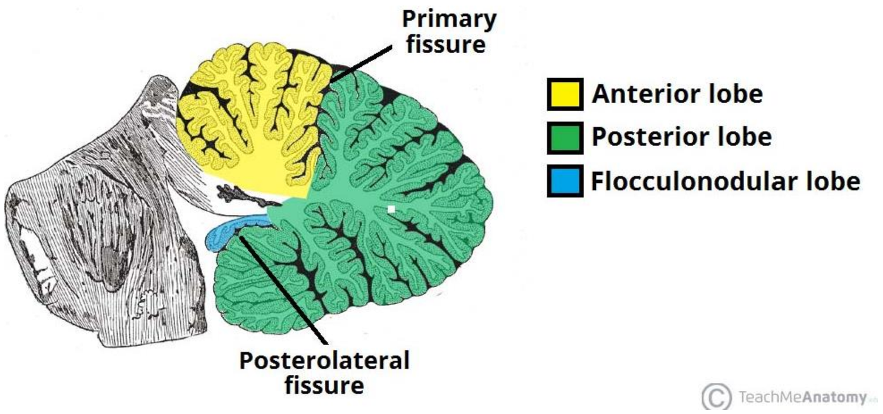


Figure 1.10: Anatomical Lobes

Zones

There are three cerebellar zones. In the midline of the cerebellum is the vermis. Either side of the vermis is the intermediate zone. Lateral to the intermediate zone are the lateral hemispheres. There is no difference in gross structure between the lateral hemispheres and intermediate zones.

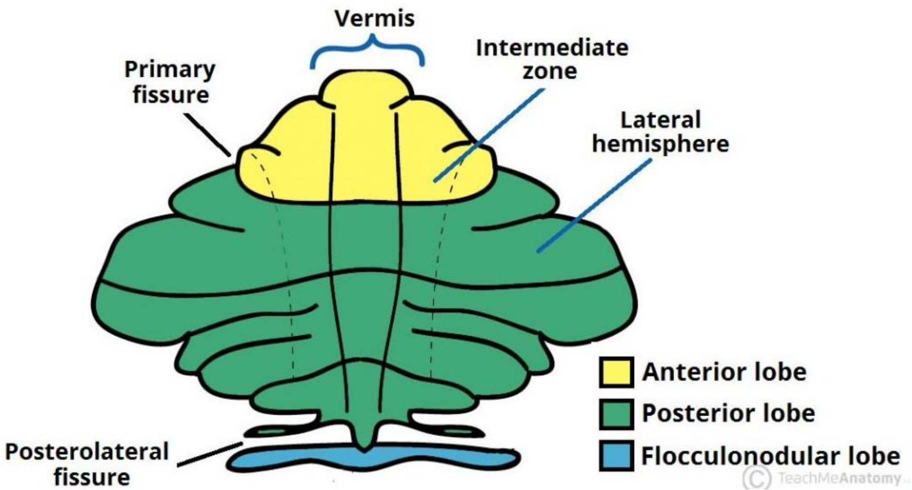


Figure 1.11: Zones

Functional Divisions

The cerebellum can also be divided by function. There are three functional areas of the cerebellum – the cerebrocerebellum, the spinocerebellum and the vestibulocerebellum.

- **Cerebrocerebellum** – the largest division, formed by the lateral hemispheres. It is involved in planning movements and motor learning. It receives inputs from the cerebral cortex and pontine nuclei, and sends outputs to the thalamus and red nucleus. This area also regulates coordination of muscle activation and is important in visually guided movements.

- **Spinocerebellum** – comprised of the vermis and intermediate zone of the cerebellar hemispheres. It is involved in regulating body movements by allowing for error correction. It also receives proprioceptive information.

- **Vestibulocerebellum** – the functional equivalent to the flocculonodular lobe. It is involved in controlling balance and ocular reflexes, mainly fixation on a target. It receives inputs from the vestibular system, and sends outputs back to the vestibular nuclei.

1.6 BRAIN STEM

Brainstem is a region at the base of the brain between the cerebral hemisphere's deep structures and the cervical spinal cord and plays a crucial part for controlling some unintentional bodily movements, including heartbeat and breathing. The middle-brain (mesencephalon), the pons (metencephalon), and the medulla oblongata in human beings are split into three segments (myelencephalon).

There are many of the control centres, such as swallowing, respiratory and vasomotor control, for the important bodily processes. All nerve cranial, save olfaction and visual ones, are situated in the brain stem and provide the cranium's structures with motor and sensory functions, including face muscle, tongue, larynx and taste, balance and hearing. The brainstem also contains significant nuclei for the function of sympathy and para sympathy. All efferent and afferent routes between the brain and brain stem and many of those inside that structure decompose or cross.

Even relatively tiny brain stroke injuries may have a dramatic impact because to the significant neuronal structures in this little part of the nervous system. Problems of speech, vestibular distortion, aberrant awareness, dysphagia, and breathing disorders are some potential instances. Trauma, tumours, strokes, infections, and demyelination may be responsible for such diseases (multiple sclerosis). Certain doctors consider complete loss of brain stem function to be equal to brain death.

1.7 NEURONS AND SIGNAL TRANSMISSION

There are two different types of sensory neurons: neurons and glia in the central nervous system [CNS]. Therefore, every data processing system in the CNS has neurons and glia; furthermore the systems are formed by networks (and the maps). Obviously, the CNS cannot perform what it does without these two kinds of cells (which is everything having to do with our minds and how we move our bodies). But what are neurons and glias doing? What functions are they?

Neurons are the fundamental structures in the CNS for information processing. Everything above the neuron level is also a processing of information. But there is nothing below neurons. We will disregard the rather contentious concept termed the neuronal doctrine. What's not disputed is that the neuron has the role of receiving INPIUT "information" from other neurons, then sending "information" to other neurons as OUTPUT. (Synapses are neuronal connections via which information travels from neuron to neuron.) Hence, all the "information" that is flowing in and out of the CNS is processed by neurons. Everything! All the motor information we are able to move through; all the sensorial information we can see, hear, smell, taste, touch with; and naturally all the cognitive information that we are able to understand, think, imagine, plan, remember and accomplish with our brains. There may be as many as 10,000 types of neurons for the treatment of so many sorts of information. Many neurons are required to process so much information. What are the number of? Well, 'best estimates' show that the brain alone has around 200 billion neurons! Each neuron is linked between 5,000 and 200,000 other neurons, therefore it is more than the numbers of stars in the cosmos that information travels in the brain!

Although we look into statistics, it's worth remembering that our CNS contains as much as 50 times as many glia as neurons! The neurons supported by the glia (or glial cells) are the cells. Just as the foundation, framework, walls, and rooftop of a house demonstrate the structure by which various electric, cable, telephone and water and waste pipes operate, glia not only offers the structural framework to keep the neuronal networks connected but also serves the different home-handling functions of the brain (such as removing debris after neuronal death).

Since we mainly want to explore how the data processing takes place in the brain, we will overlook the glia. But you must know certain facts about the anatomy of neurons before we can understand how neurons process information (and what it implies).

Structure of neurons

While the human brain usually has as many as 10,000 distinct types of neurons, there are three categories of neurons: motor neurons (for transmitting motor information), sensory neurons, and interneurons (which convey information between different types of neurons). The picture below shows how neurons come in many forms and sizes. (Based on Cajal's illustrations.)

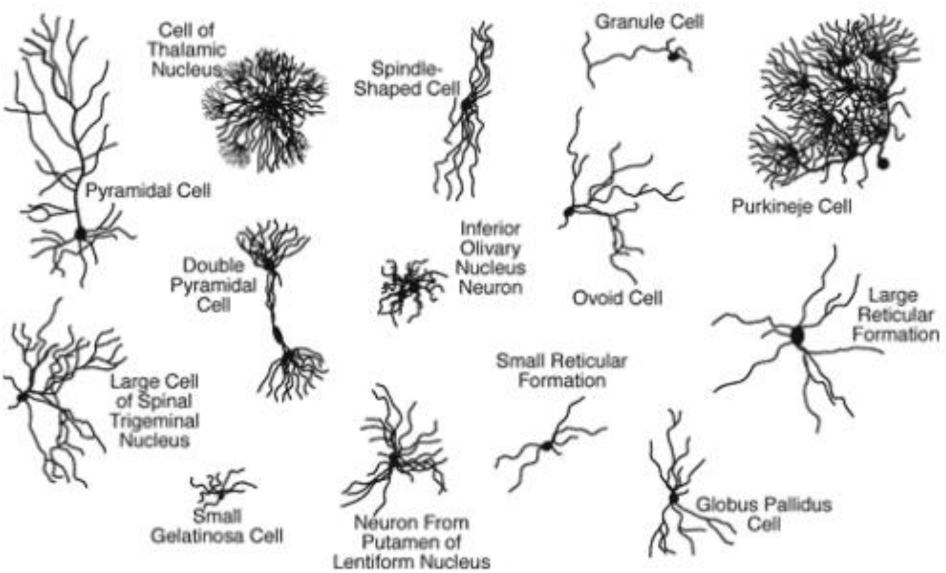


Figure 1.12: Structure of neurons

There are four components of a typical neuron (or regions). The first portion is the body of the cell (or soma). It is also the "production and recycling plant," not just the metabolic "control centre" of the neuron. (The neuronal proteins are produced in the cell's body, for example.) Processes are the second and third portions – structures that are far from the cell body. The role of a process should generally be a conduit via which signals flow into or out of the cell body. Incoming signals are usually received via its dendrites from other neurons. The output signal travels via his axon to other neurons. A neuron may contain a thousand dendrites, but only one axon will be present. At the termination of the axon, the axon ends, lies the fourth separate component of a neuron. These are the neurotransmitter structures. Neurotransmitters are the chemical medium through which messages travel at chemical synapses from one neuron to another.

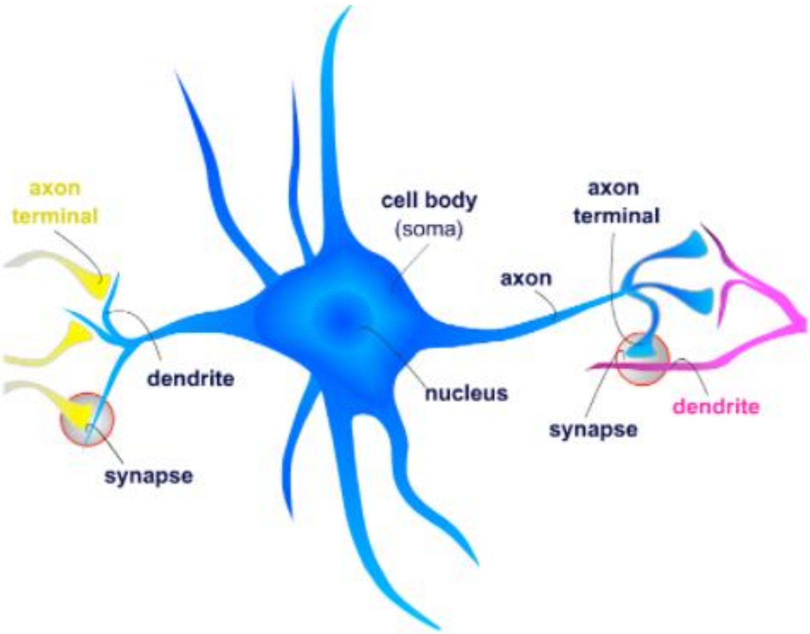


Figure 1.13: Neuron

Neuronal signalling

Neurons have developed distinct capacities for intracellular (communication inside the cell) and intercellular communication to support the overall operation of the nervous system (communication between cells). Neurons have unique skills for transmission of electrical impulses (action potential) on axons to enable long-distance, fast communication. The cell body of a neuron interacts with its own terminals via the axon, this process, termed conduction. Neuron communication is accomplished via the neurotransmission mechanism during synapses.

Conduction

A potential for action is created near the cellular part of the axon to initiate conduction. An electrical signal is an action potential similar to electrical signals in electronic equipment. But whereas an electronic signal happens on electrons moving down a wire, an electrical signal arises in a neuron due to neuronal membrane ion movement. Ions are charged particles electrically. The neuron protein membrane serves as an ion barrier. Ions pass across the membrane via ion channels that are open and shut according to neurotransmitter presence. The electrical property of the membrane varies as the concentration of ions within the neuron changes. Normally the neuron's membrane potential is -70 mv (and the membrane is said to be polarized). The inflow and outflow of ions (through neurotransmission ion channel) will make it more positive within the target neuron (hence, de-polarized). When the depolarization reaches a non-return point known as a threshold, a significant electric signal is produced.

This signal will be spread through the axon until it reaches its axon terminals, and not, example, back to its dendrites. The axon is moved fast by an active potential, travelling up to 150 meters per second (or about 500 feet). Lead ends on the terminals of the axons. Neurotransmission starts in Axon terminals. Therefore, the neuron transmits its OUTPUT to other neurons at axon terminals. The OUTPUT will be the electric signal itself in electric synapses. The OUTPUT is neurotransmitter in chemical synapses.

Neurotransmission

The communication between neurons, as achieved via the passage of chemical or electrical impulses through a synapse, consists of neurosis (or synaptic transmission). For each interneuron its job is to accept INPUT information from other neurons by means of synapses, then to transmit the information as OUTPUT to other neurons by means of synapses. Therefore, if an interneuron is not linked to other neurons in a network, it cannot perform its job. A neuron network is only one set of neurons through which information travels between neurons. neurons are a network of neurons. The following picture shows a neural network. "Information" travels via electrical synapses between the blue neurons. 'Information' travels through blue neuron B from yellow neuron A via chemical synapses to pink neuron C.

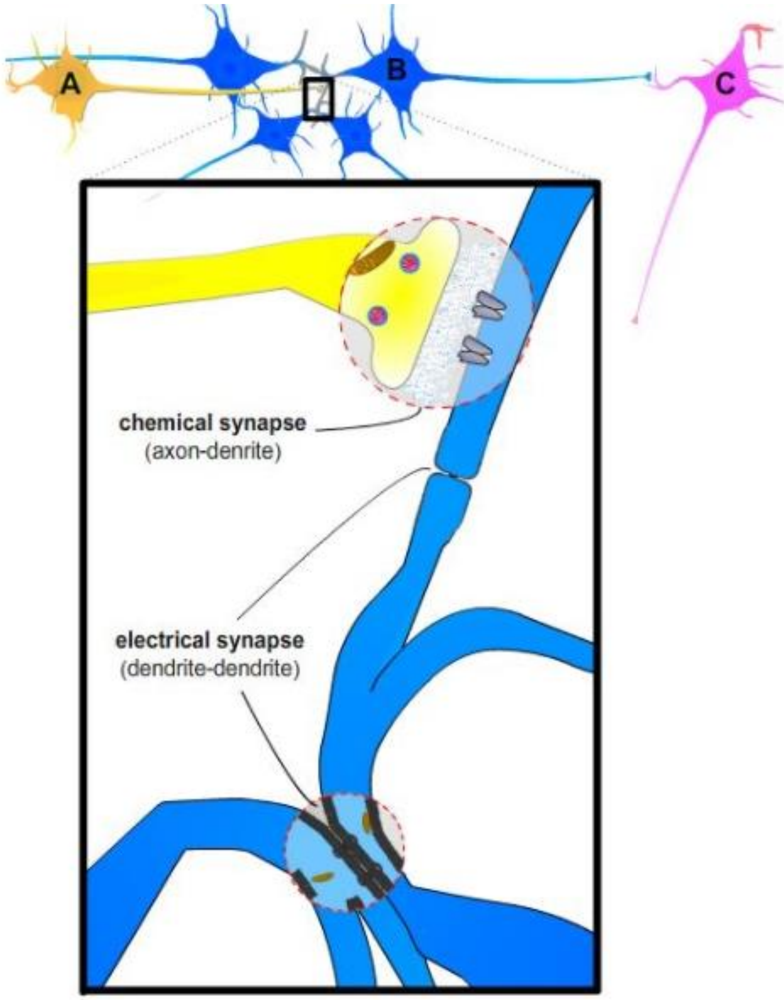


Figure 1.14: Neurotransmission

1.7.1 Synapses

At electrical synapses, two neurons are physically connected to one another through gap junctions. Gap junctions permit changes in the electrical properties of one neuron to affect the other, and vice versa, so the two neurons essentially behave as one. Electrical neurotransmission is communication between two neurons at electrical synapses. How this occurs is explored in a bit more detail in the following animation.

Chemical neurotransmission occurs at chemical synapses. In chemical neurotransmission, the presynaptic neuron and the postsynaptic neuron are separated by a small gap — the synaptic cleft. The synaptic cleft is filled with extracellular fluid (the fluid bathing all the cells in the brain).

Although very small, typically on the order of a few nanometres (a billionth of a meter), the synaptic cleft creates a physical barrier for the electrical signal carried by one neuron to be transferred to another neuron. In electrical terms, the synaptic cleft would be considered a "short" in an electrical circuit. The function of neurotransmitter is to overcome this electrical short. It does so by acting like a chemical messenger, thereby linking the action potential of one neuron with a synaptic potential in another. How this occurs is illustrated in the following animation.

1.8 SENSES

Sense is a biological mechanism adopted by a sensational creature to collect and react to the stimulation of information about the surroundings. (The brain, for example, gets messages from the senses in the human body, which receives information from the environment, interprets those signals and produces a chemical or physical response from the body.) Although approximately five humans have historically been known (i.e. vision, smell, touch, taste, hearing), many more are now acknowledged. The range and quantity of senses exploited by other non-human creatures is much larger. During feeling, sensory organs gather different inputs for transduction (like a son or a scent), transforming them into a form which the brain can understand. Sensation and awareness are crucial to almost every element of the cognition, action and thinking of an organism.

The sensory organ in organisms consists of a collection of sensory cells connected to a certain kind of physical input. The various types of sense-receptor cells (for instance mechanoreceptors, photoreceptors, chemoreceptors, thermo-receptors), transmit sensory information from and from these bodies into the central nervous system, finally reaching the senses, via cranial and spinal nerves (Central and Peripheral nervous systems that transmit sense-related data to and from the brain and body) (perceived).

Sensory systems are typically separated into exterior sensory systems (exteroception) and interior systems (interception). The sensory bodies of the eyes, ears, skin, nose, and mouth are founded on the human exterior senses. Interior sensibility detects internal tissue and organ impulses. The vestibular system (balance sense) that the inner ear detects and others such as spatial orientation, proprio-position and nociception are part of internal senses owned by humans (pain). Other inside sense signals such as hunger, thirst, suffocation and sickness or many unintentional actions like vomiting contribute to more internal senses. Some animals can detect electrical and magnetic fields, air humidity and polarization light, while other species can feel and comprehend alternate systems like echolocation. Sensory modalities are various methods of encrypting or translating sensory information. In a united perceptive experience, multimodality combines several senses. For instance, information from one sense may affect the perception of information from another. A number of linked areas, including psychotherapy, neurobiology, cognitive psychology and cognitive science, are studying sensation and perception.

1.8.1 Vision

The eye is the main visual sense organ. Light waves are passed across the cornea and the pupil is in the eye. The cornea is the clear cover of the eye. It acts as a barrier between the internal eye and the outside environment, and it concentrates on light waves entering the eye. The pupil is the tiny aperture of the eye that passes through light, and the pupil's size may vary according to luminous levels and the emotional excitement. The pupil will be dilated or enlarged when the light levels are low, so that light is let into the eye. The pupil will decrease or lessen the quantity of light that enters the eye when the levels of light are high. The size of the pupil is regulated by the muscles linked to the iris, the coloured part of the eye.

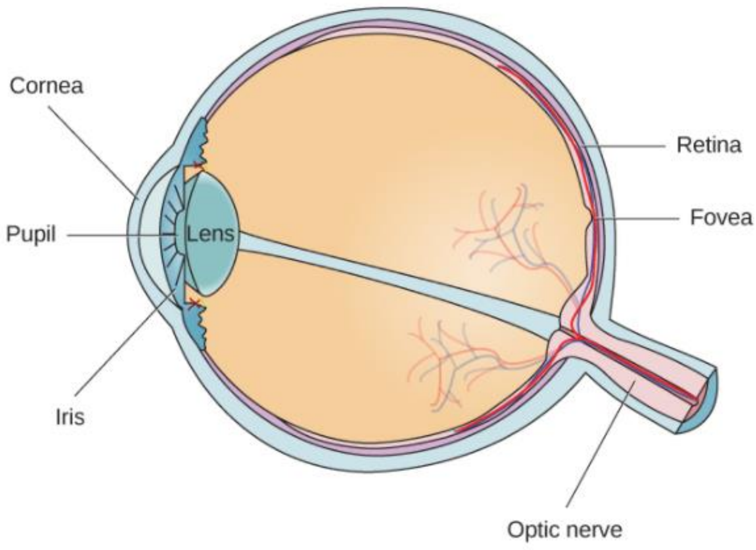


Figure 1.15: The anatomy of the eye is illustrated in this diagram

After the pupil passes, light passes through the lens, which provides an extra focus with a curved, transparent construction. The lens is connected to the muscles, which may bend it to help concentrate light from close or far-flung objects. In a normally-sighted person, the lens precisely focuses pictures on the light-sensitive rear of the eye known as the fovea that is part of the retina. Fovea has unique photoreceptor cells that are tightly packed. The cells known as cones are photoreceptor cells that sense light. The cones are specialised photoreceptor kinds which function best under light settings. Cones are very sensitive and have a great resolution to acute details. They also participate directly in our colour perception abilities.

While cones are localised in fovea, with images tending to be concentrated, rods are distributed across the rest of the retina, a different kind of photoreceptor. Rods, which operate effectively in low light circumstances, are specialised photoreceptors and although they lack cones' space resolution and colour, participate in human vision in poorly lit environments as well as in our sense of movement at the periphery of our visual field.

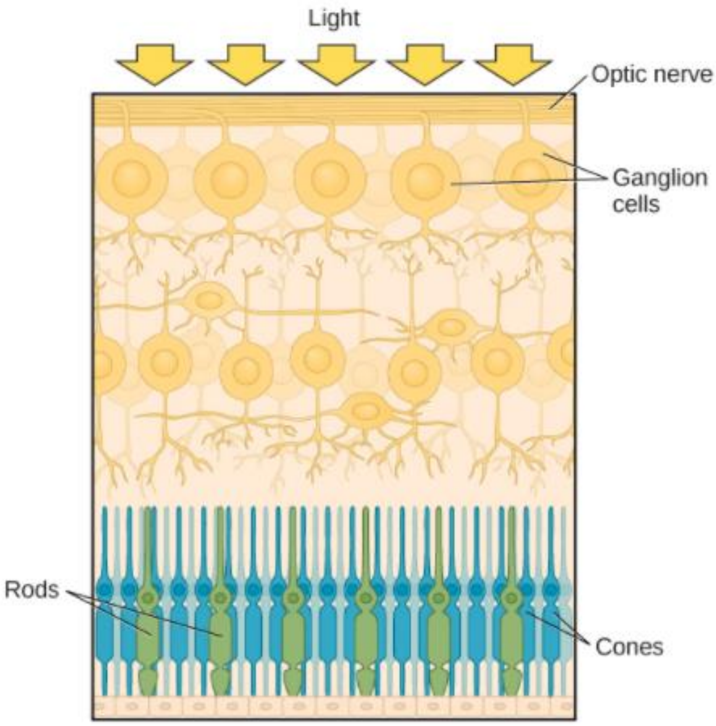


Figure 1.16: The two types of photoreceptors are shown in this image. Rods are coloured green and cones are blue.

When the shift from a lightweight environment to a dimly-lit environment, we all experienced the various sensitivities of rods and cones. Imagine watching a film on a clear day in the summer. When you enter the gloomy theatre from the brilliantly illuminated foyer, you will discover you have trouble seeing at so much. You start to adapt to the darkness after a few of minutes and glimpse the inside of the theatre. Your view was mostly dominated by cone activity in the bright surroundings. The rod activity predominates as you go into the dark environment, although transition between the phases is delayed. You have trouble seeing in the low light, a condition known as a nightlight, if your rods do not convert light into nerve impulses as readily and effectively as they should.

1.8.2 Hearing

Hearing is the mechanism by which the ear converts sound vibrations into nerve pulses in the external world that are sent to the brain as sound. Sounds arise from vibrating things such as the plucked guitar string that generate vibrating air molecules pressure pulses, better called sound waves. In detecting and interpreting many physical properties of the waves, the ear can discern various subjective elements of a sound, including its volume and pitch. Pitch is the impression of the sound wave frequency—i.e. the number of wavelengths passing through a given location in a unit of time. Frequency in cycles per second or in hertz is often measured. The ear is the most sensitive and most readily detectable of frequencies ranging from 1,000 to 4,000 hertz, although the whole spectrum of sounds is at least 20 to 20,000 hertz in younger audiences. Sound waves are referred to as ultrasound waves of still higher frequency, but other animals may be heard. Loudness is the impression of sound intensity — that is, the pressure on the tympanic membranes imposed by sound waves. The higher their amplitude or strength, and thus the loudness of the acoustic, the greater the pressure or intensity. A metric that represents the relative sound magnitude on a logarithmic scale, the sound intensity is measured and reported in decibles (dB). In other words, the decibel is a measure that allows the strength of a particular sound to be compared with a standard sound which is just detectable to the typical human ear at a frequency that is most sensitive to the ear. On the decibel scale, the human hearing range ranges from 0 dB, a level that is almost inaudible, to approximately 130 dB, the sound level that is unpleasant. (See the sound for a more thorough debate.)

The sound energy undergoes three changes to transfer it into the central nervous system. First, the air vibration is transferred to the tympanic membrane vibration and the middle ear occipital lobes. In turn, they form fluid fluids in the cochlea. Finally, the fluid vibrations create waves that move down the basil membrane, which encourage Corti's hair cells. These cells transform the sound vibration into nerve impulses of the cochlear nerve cell, transmitting it to the brainstem, which send them to the main auditory region of the brain cortex, which is the final core of the brain for listening after thorough treatment. The listener is only become aware of the sound when the nerve impulses reach this region.

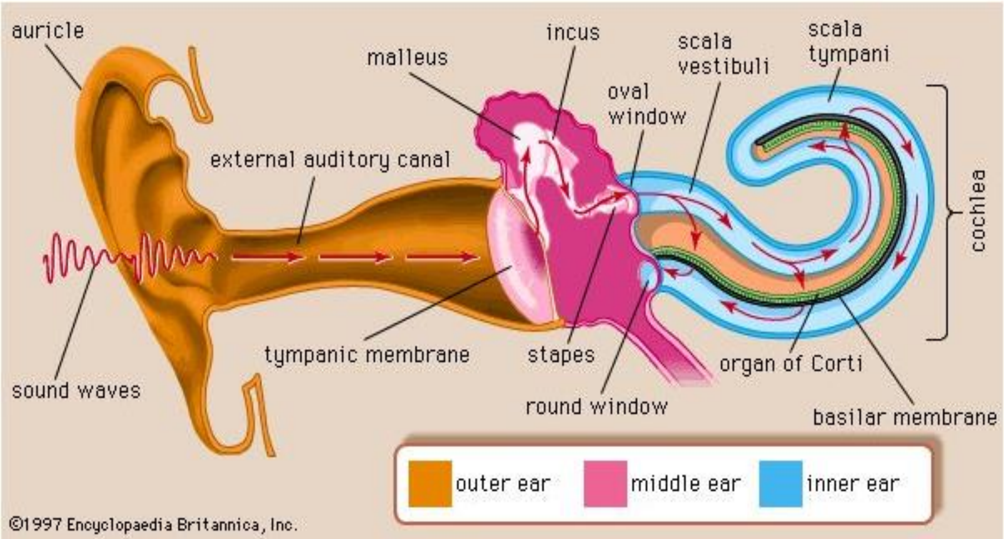


Figure 1.17: Hearing

1.8.3 Divided Hearing

The ear is divided into many parts. The outside ear comprises the pinna, the visible ear of the head, the audible canal and the tympanic membrane, namely the eardrum. If sound waves enter the ear, the pathogens on both sides contract whatever the ear is stimulated. These muscles tighten up also when we are exposed to loud noises and are related to the ossicles. But this is not successful; the muscle reflection is too sluggish to shield us, like a gunshot, from the rash noises. And after a time, the muscles adjust. The stapedius reflex is referred to.

Sound waves pass via the sound channel and resonate in the tympanic membrane. In the middle ear, the movement of the sound is amplified by the three ossicles (incus, malleus and steps). The oscines migrate into a thin cochlea membrane called the oval window and push the stapes into it (the beginning of the inner ear). After that fluid moves into the cochlea, which in turn activates hair cells that are auditory receptor cells of the inner ear implanted in the membrane of the basilar (more on the basilar membrane in the next section). The main cause for the increase in sound pressure waves is that the energy is passed from air to fluid (inner ear/cochlea). Air and water have different impedances, which implies that air with air pressure waves is simpler to move than water.

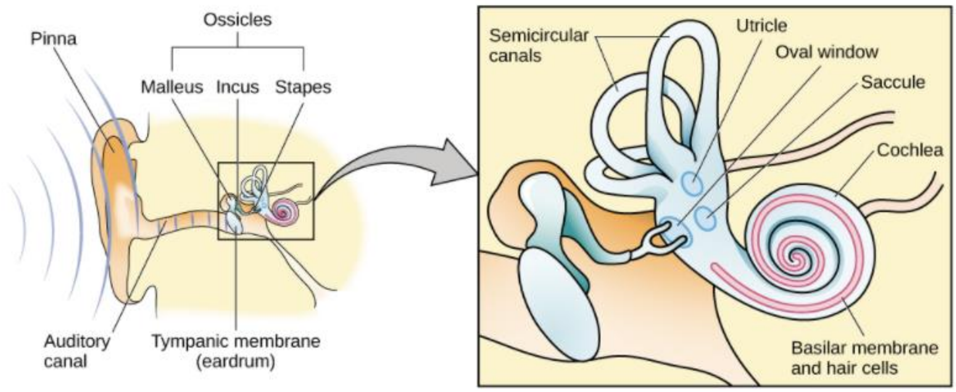


Figure 1.18: The ear is divided into outer (the pinna and the tympanic membrane), middle (the three ossicles: malleus, incus, and stapes), and the inner ear

1.8.4 The Taste and the Olfactory Sensations

Stimulation of both contaminates are chemicals obtained from the environment. Human tastes are primarily sweet, sour, bitter, salty and umami. The first four senses need minimal clarification. Umbria has lately been identified as a basic flavour. It was discovered in 1908 using a seaweed broth by a Japanese scientist Kekune Ikeda, but not generally recognised as a flavour which could be differentiated physiologically until years later. The umami taste, often referred to as savoury flavour, is due to the amino acid L- glutamate taste. In reality, monosodium glutamate (MSG) is often used to improve the delicious flavour of various dishes in the cooking process. The adaptive benefit of distinguishing umami is because salty foods are often rich in protein.

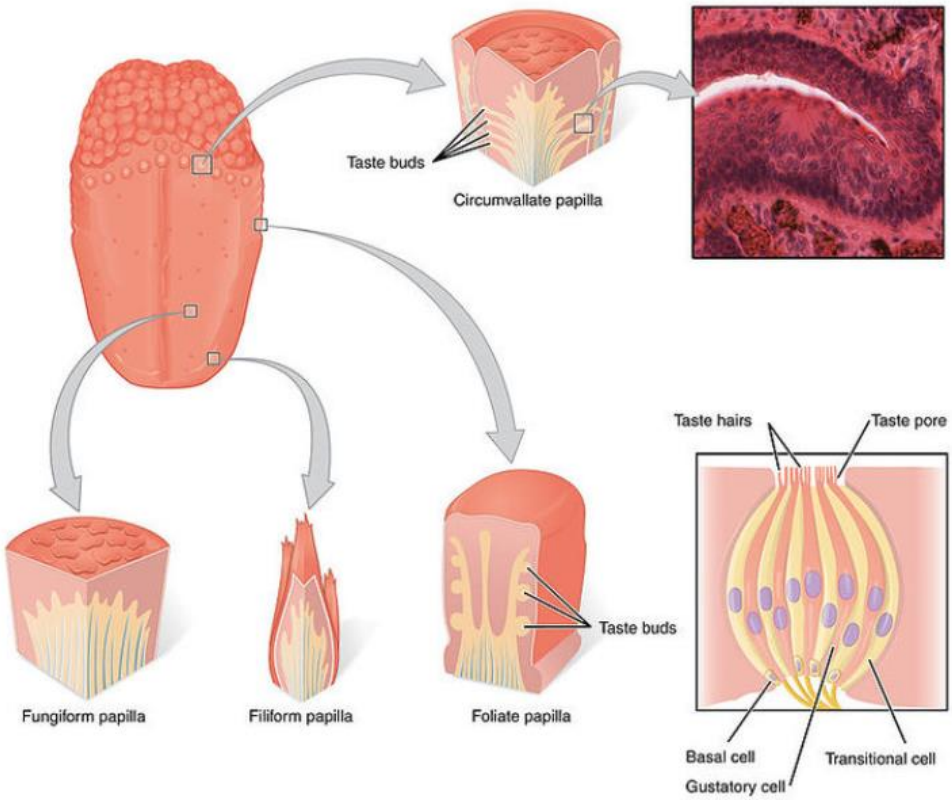


Figure 1.19: Uniform Distribution of Taste Receptors

All smells are molecules in the air we breathe. If a material does not release molecules from its surface into the air, it has no fragrance. If there is no receptor for a particular chemical in a human or other animal, then that molecule has no scent. There are about 350 olfactory receptor subtypes in people which work together to senses over 10,000 distinct smells. For example, compare that to mice that have around 1300 olfactory receptor types and presumably feel much more scent, accordingly.

At the back of the throat the sensations of smell and taste are combined. The fragrance that stays internally to the nose causes you to smell, if you taste anything before you feel it. Chemo receptors both smell and taste, which implies that both senses the chemical environment. The existence of specific taste receptors in the tongue which have been designated as taste cells and are grouped together to form taste buds is the way this chemical reception takes place in relation to flavor. Situated in tongue-wide papillae, these taste buds are unique to the five modalities: salt, sweet, sweet, bitter and umami. Their particular stimuli, (e.g., sweet, salt molecules) and messages to the brain are activated. These receptors are active.

Beside activation of the taste receptors, comparable receptors are found in the nose that co-ordinate with taste receptor activity. You can sense the difference in sweetness from bitter when you consume anything. The feeling of scent is utilized to differentiate the difference. Although people usually differentiate taste like one meaning and smell like another, they operate together to produce the feeling of taste. When he or she has clogged nasal passages, a person's sense of taste is diminished.

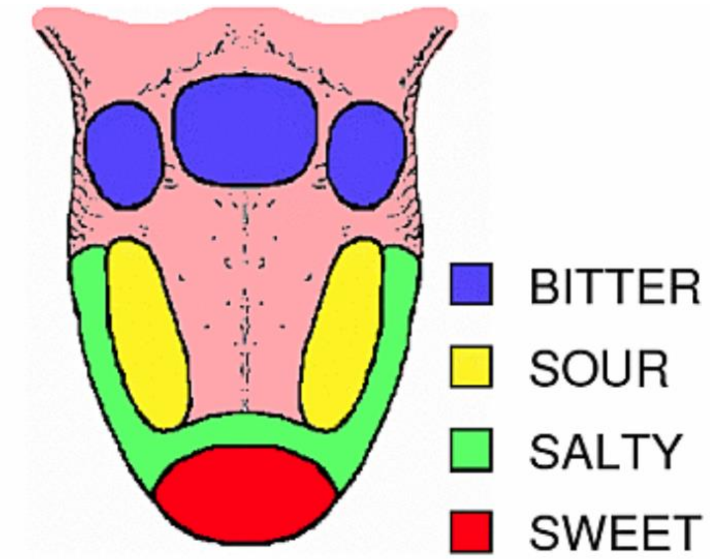


Figure 1.20: Uniform distribution of taste receptors

1.8.5 Primary Taste Sensations

There are five primary taste sensations

Sweet

You probably have or know someone who has a "sweet tooth." It has a nicer ring to it than sweet tongue, doesn't it? Sweetness is often described as the pleasure taste, signaling the presence of sugar, which is a core source of energy and hence, desirable to the human body. It is no wonder that this is a taste that even babies gravitate to.

Furthermore, when used in a combination, sweet complements well with the other basic tastes. Adding sweetness such as a drizzle of sweet balsamic glaze to a traditionally salty vegetable dish like roasted brussel sprouts would take it to the next level.

Salty

The simplest taste receptor in the mouth is the sodium chloride receptor. Salt is a necessary component to the human diet and enhances the flavor of foods. However, the average American tends to consume way more than needed (about 2-3 times above the FDA's recommended daily limit), and our palates adapt to crave more salt. Interestingly enough, when people cut back on salt in their diets, taste buds can adjust again and adapt to be satisfied with less.

As a flavor enhancer, adding salt to traditionally sweet dishes is necessary to amplify the sweet notes. A pinch of salt is core to most baked dessert recipes. Even if it is not listed in the ingredients, sprinkling some sea salt flakes or smoked salt over holiday ginger bread cookies brings out the sweetness of the sugar and enhances the ginger flavor.

Sour

Sourness is a taste that detects acidity. These taste buds detect hydrogen ions from organic acids found in foods. The mouth puckering sensation is common in citric fruits such as lemons and oranges, as well as tamarind and some leafy greens. The sour taste can also be obtained from foods soured through fermentation such as sauerkraut and yogurt, or through the addition of vinegar.

Many salad dressings feature vinegar as a key ingredient, which is a perfect way to add sour notes. You could also try adding lemon or orange zest to vinegar or even cream based dressings. Or, simply zest the top of your salad to help drive this crave able flavor sensation.

Bitter

Bitter is the most sensitive of the five tastes. A large number of bitter compounds are known to be toxic, which is why many perceive bitter flavors to be unpleasant. Hundreds of substances, mostly found in plants, taste bitter. However, a little bitterness can make food more interesting and have become beloved, like the hoppy taste in beer. Furthermore, there are cases where some bitterness could be healthy. Antioxidants, which aid in metabolism, account for the bitter taste in dark chocolate and coffee.

Dark chocolate shavings on top of your favorite holiday dessert could be a great addition to create a fun bitter flavor party.

Umami

Umami is an appetitive taste, sometimes described as savory or meaty. It is the most recently identified and accepted of the basic tastes. In the early part of the 20th century, a Japanese chemist named Kikunae Ikeda attempted to identify this taste common to asparagus, tomatoes, cheese and meat. But, not one of the four well-known tastes could describe it adequately. What he pinpointed was the presence of glutamic acid, which he renamed “umami”, Japanese for “good flavor”. Though one of the core flavors of Eastern cuisine imparted by soy sauce and MSG (monosodium glutamate), it wasn’t accepted as a basic taste in the West until 1985.

1.8.6 The Sense of Smell

As we breathe in air through our nostrils, we inhale airborne chemical molecules, which are detected by the 10 million to 20 million receptor cells embedded in the olfactory membrane of the upper nasal passage. The olfactory receptor cells are topped with tentacle-like protrusions that contain receptor proteins. When an odour receptor is stimulated, the membrane sends neural messages up the olfactory nerve to the brain.

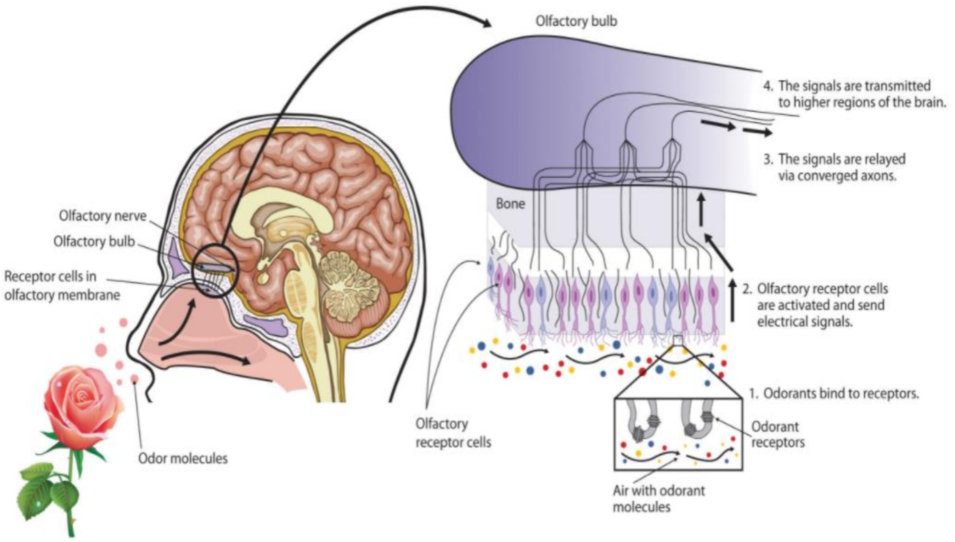


Figure 1.21: Smell Receptors.

There are more than 1,000 types of odour receptor cells in the olfactory membrane.

We have approximately 1,000 types of odour receptor cells, and it is estimated that we can detect 10,000 different odours. The receptors come in many different shapes and respond selectively to different smells. Like a lock and key, different chemical molecules fit into different receptor cells, and odours are detected according to their influence on a combination of receptor cells. Just as the 10 digits from 0 to 9 can combine in many different ways to produce an endless array of phone numbers, odour molecules bind to different combinations of receptors, and these combinations are decoded in the olfactory cortex. "Age Differences in Smell," the sense of smell peaks in early adulthood and then begins a slow decline. By ages 60 to 70, the sense of smell has become sharply diminished. In addition, women tend to have a more acute sense of smell than men.

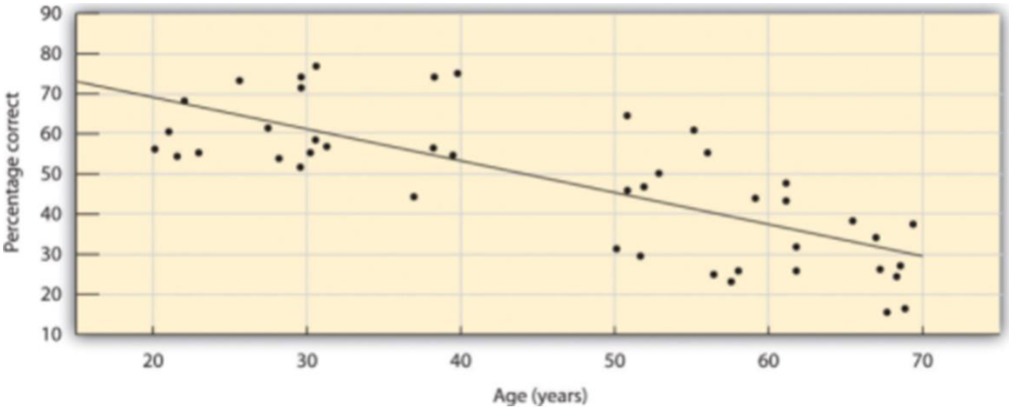


Figure 1.22: Age Differences in Smell. The ability to identify common odourants declines markedly between 20 and 70 years of age.

1.8.7 Touch

The sense of touch is essential to human development. Infants thrive when they are cuddled and attended to, but not if they are deprived of human contact. Touch communicates warmth, caring, and support, and is an essential part of the enjoyment we gain from our social interactions with close others.

The skin, the largest organ in the body, is the sensory organ for touch. The skin contains a variety of nerve endings, combinations of which respond to particular types of pressures and temperatures. When you touch different parts of the body, you will find that some areas are more ticklish, whereas other areas respond more to pain, cold, or heat.

The thousands of nerve endings in the skin respond to four basic sensations — pressure, hot, cold, and pain — but only the sensation of pressure has its own specialized receptors. Other sensations are created by a combination of the other four. For instance:

- The experience of a tickle is caused by the stimulation of neighboring pressure receptors.
- The experience of heat is caused by the stimulation of hot and cold receptors.
- The experience of itching is caused by repeated stimulation of pain receptors.
- The experience of wetness is caused by repeated stimulation of cold and pressure receptors.

The skin is important not only in providing information about touch and temperature, but also in proprioception — the ability to sense the position and movement of our body parts. Proprioception is accomplished by specialized neurons located in the skin, joints, bones, ears, and tendons, which send messages about the compression and the contraction of muscles throughout the body. Without this feedback from our bones and muscles, we would be unable to play sports, walk, or even stand upright.

The ability to keep track of where the body is moving is also provided by the vestibular system, a set of liquid-filled areas in the inner ear that monitors the head's position and movement, maintaining the body's balance. As you can see in Figure 5.22, "The Vestibular System," the vestibular system includes the semicircular canals and the vestibular sacs. These sacs connect the canals with the cochlea. The semicircular canals sense the rotational movements of the body, and the vestibular sacs sense linear accelerations. The vestibular system sends signals to the neural structures that control eye movement and to the muscles that keep the body upright.

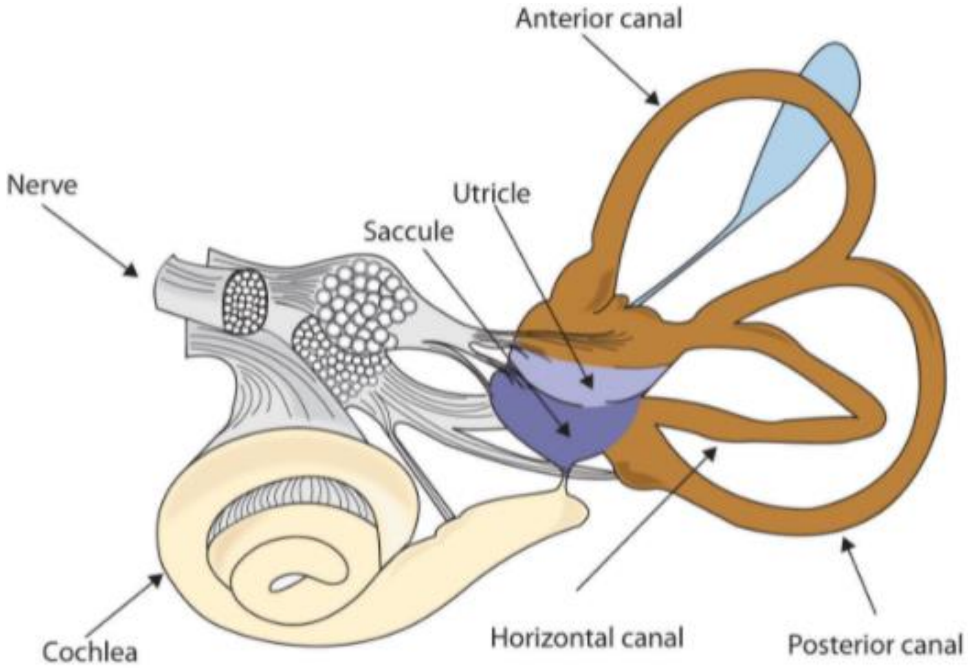


Figure 1.23: The Vestibular System. The vestibular system includes the semi-circular canals (brown) that transduce the rotational movements of the body, and the vestibular sacs (blue) that sense linear accelerations.

Experiencing Pain

We do not enjoy it, but the experience of pain is how the body informs us that we are in danger. The burn when we touch a hot radiator and the sharp stab when we step on a nail lead us to change our behaviour, preventing further damage to our bodies. People who cannot experience pain are in serious danger of damage from wounds that others with pain would quickly notice and attend to.

The gate control theory of pain proposes that pain is determined by the operation of two types of nerve fibres in the spinal cord. One set of smaller nerve fibres carries pain from the body to the brain, whereas a second set of larger fibres is designed to stop or start (as a gate would) the flow of pain. It is for this reason that massaging an area where you feel pain may help alleviate it — the massage activates the large nerve fibres that block the pain signals of the small nerve fibres.

Experiencing pain is a lot more complicated than simply responding to neural messages, however. It is also a matter of perception. We feel pain less when we are busy focusing on a challenging activity, which can help explain why sports players may feel their injuries only after the game. We also feel less pain when we are distracted by humor. And pain is soothed by the brain's release of endorphins, natural hormonal pain killers. The release of endorphins can explain the euphoria experienced in the running of a marathon

1.9 COMPLEXITY OF PERCEPTION

Perception refers to the set of processes we use to make sense of all the stimuli you encounter every second, from the glow of the computer screen in front of you to the smell of the room to the itch on your ankle. Our perceptions are based on how we interpret all these different sensations, which are sensory impressions we get from the stimuli in the world around us. Perception enables us to navigate the world and to make decisions about everything, from which T-shirt to wear or how fast to run away from a bear.

Close your eyes. What do you remember about the room you are in? The color of the walls, the angle of the shadows? Whether or not we know it, we selectively attend to different things in our environment. Our brains simply don't have the capacity to attend to every single detail in the world around us. Optical illusions highlight this tendency. Have you ever looked at an optical illusion and seen one thing, while a friend sees something completely different? Our brains engage in a three-step process when presented with stimuli: selection, organization, and interpretation.

For example, think of Rubin's Vase, a well-known optical illusion depicted below. First, we select the item to attend to and block out most of everything else. It's our brain's way of focusing on the task at hand to give it our attention. In this case, we have chosen to attend to the image. Then, we organize the elements in our brain. Some individuals organize the dark parts of the image as the foreground and the light parts as the background, while others have the opposite interpretation.

Some individuals see a vase because they attend to the black part of the image, while some individuals see two faces because they attend to the white parts of the image. Most people can see both, but only one at a time, depending on the processes described above. All stages of the perception process often happen unconsciously and in less than a second.

The Perception Process

The perceptual process is a sequence of steps that begins with stimuli in the environment and ends with our interpretation of those stimuli. This process is typically unconscious and happens hundreds of thousands of times a day. An unconscious process is simply one that happens without awareness or intention. When you open your eyes, you do not need to tell your brain to interpret the light falling onto your retinas from the object in front of you as “computer” because this has happened unconsciously. When you step out into a chilly night, your brain does not need to be told “cold” because the stimuli trigger the processes and categories automatically.

Selection

The world around us is filled with an infinite number of stimuli that we might attend to, but our brains do not have the resources to pay attention to everything. Thus, the first step of perception is the (usually unconscious, but sometimes intentional) decision of what to attend to. Depending on the environment, and depending on us as individuals, we might focus on a familiar stimulus or something new. When we attend to one specific thing in our environment—whether it is a smell, a feeling, a sound, or something else entirely—it becomes the attended stimulus.

Organization

Once we have chosen to attend to a stimulus in the environment (consciously or unconsciously, though usually the latter), the choice sets off a series of reactions in our brain. This neural process starts with the activation of our sensory receptors (touch, taste, smell, sight, and hearing). The receptors transduce the input energy into neural activity, which is transmitted to our brains, where we construct a mental representation of the stimulus (or, in most cases, the multiple related stimuli) called a percept. An ambiguous stimulus may be translated into multiple percepts, experienced randomly, one at a time, in what is called “multicable perception.”

Interpretation

After we have attended to a stimulus, and our brains have received and organized the information, we interpret it in a way that makes sense using our existing information about the world. Interpretation simply means that we take the information that we have sensed and organized and turn it into something that we can categorize. For instance, in the Rubin’s Vase illusion mentioned earlier, some individuals will interpret the sensory information as “vase,” while some will interpret it as “faces.” This happens unconsciously thousands of times a day. By putting different stimuli into categories, we can better understand and react to the world around us.

1.10 COGNITION, MEMORY, LEARNING

Upon waking each morning, you begin thinking—contemplating the tasks that you must complete that day. In what order should you run your errands? Should you go to the bank, the cleaners, or the grocery store first? Can you get these things done before you head to class or will they need to wait until school is done? These thoughts are one example of cognition at work. Exceptionally complex, cognition is an essential feature of human consciousness, yet not all aspects of cognition are consciously experienced. Cognitive psychology is the field of psychology dedicated to examining how people think. It attempts to explain how and why we think the way we do by studying the interactions among human thinking, emotion, creativity, language, and problem solving, in addition to other cognitive processes. Cognitive psychologists strive to determine and measure different types of intelligence, why some people are better at problem solving than others, and how emotional intelligence affects success in the workplace, among countless other topics. They also sometimes focus on how we organize thoughts and information gathered from our environments into meaningful categories of thought, which will be discussed later.

Categories and Concepts

A **category** a set of objects that can be treated as equivalent in some way. For example, consider the following categories: trucks, wireless devices, weddings, psychopaths, and trout. Although the objects in a given category are different from one another, they have many commonalities. When you know something is a truck, you know quite a bit about it. The psychology of categories concerns how people learn, remember, and use informative categories such as trucks or psychopaths.The mental representations we form of categories are called concepts. There is a category of trucks in the world, and you also have a concept of trucks in your head. We assume that people’s concepts correspond more or less closely to the actual category, but it can be useful to distinguish the two, as when someone’s concept is not really correct.

Concepts and Prototypes

The human nervous system is capable of handling endless streams of information. The senses serve as the interface between the mind and the external environment, receiving stimuli and translating it into nervous impulses that are transmitted to the brain. The brain then processes this information and uses the relevant pieces to create thoughts, which can then be expressed through language or stored in memory for future use. To make this process more complex, the brain does not gather information from external environments only. When thoughts are formed, the brain also pulls information from emotions and memories. Emotion and memory are powerful influences on both our thoughts and behaviors.

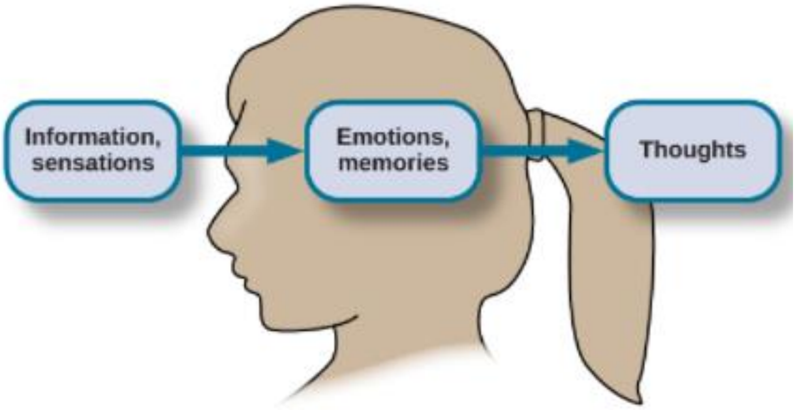


Figure 1.24: Sensations and information are received by our brains, filtered through emotions and memories, and processed to become thoughts.

In order to organize this staggering amount of information, the brain has developed a file cabinet of sorts in the mind. The different files stored in the file cabinet are called concepts. Concepts are categories or groupings of linguistic information, images, ideas, or memories, such as life experiences. Concepts are, in many ways, big ideas that are generated by observing details, and categorizing and combining these details into cognitive structures. You use concepts to see the relationships among the different elements of your experiences and to keep the information in your mind organized and accessible.

Concepts are informed by our semantic memory (you will learn more about this concept when you study memory) and are present in every aspect of our lives; however, one of the easiest places to notice concepts is inside a classroom, where they are discussed explicitly. When you study United States history, for example, you learn about more than just individual events that have happened in America's past. You absorb a large quantity of information by listening to and participating in discussions, examining maps, and reading first-hand accounts of people's lives. Your brain analyzes these details and develops an overall understanding of American history. In the process, your brain gathers details that inform and refine your understanding of related concepts like democracy, power, and freedom.

Concepts can be complex and abstract, like justice, or more concrete, like types of birds. In psychology, for example, Piaget's stages of development are abstract concepts. Some concepts, like tolerance, are agreed upon by many people, because they have been used in various ways over many years. Other concepts, like the characteristics of your ideal friend or your family's birthday traditions, are personal and individualized. In this way, concepts touch every aspect of our lives, from our many daily routines to the guiding principles behind the way government's function.

Memory is the ability to take in information, store it, and recall it at a later time. In psychology, memory is broken into three stages: encoding, storage, and retrieval.

The Memory Process

1. **Encoding (or registration):** the process of receiving, processing, and combining information. Encoding allows information from the outside world to reach our senses in the forms of chemical and physical stimuli. In this first stage we must change the information so that we may put the memory into the encoding process.

2. **Storage:** the creation of a permanent record of the encoded information. Storage is the second memory stage or process in which we maintain information over periods of time.

3. **Retrieval (or recall, or recognition):** the calling back of stored information in response to some cue for use in a process or activity. The third process is the retrieval of information that we have stored. We must locate it and return it to our consciousness. Some retrieval attempts may be effortless due to the type of information.

Problems can occur at any stage of the process, leading to anything from forgetfulness to amnesia. Distraction can prevent us from encoding information initially; information might not be stored properly, or might not move from short-term to long-term storage; and/or we might not be able to retrieve the information once it's stored.

Learning is the process of acquiring new understanding, knowledge, behaviors, skills, values, attitudes, and preferences. The ability to learn is possessed by humans, animals, and some machines; there is also evidence for some kind of learning in certain plants. Some learning is immediate, induced by a single event (e.g. being burned by a hot stove), but much skill and knowledge accumulate from repeated experiences. The changes induced by learning often last a lifetime, and it is hard to distinguish learned material that seems to be "lost" from that which cannot be retrieved.

Human learning starts at birth (it might even start before) and continues until death as a consequence of ongoing interactions between people and their environment. The nature and processes involved in learning are studied in many fields, including educational psychology, neuropsychology, experimental psychology, and pedagogy. Research in such fields has led to the identification of various sorts of learning. For example, learning may occur as a result of habituation, or classical conditioning, operant conditioning or as a result of more complex activities such as play, seen only in relatively intelligent animals. Learning may occur consciously or without conscious awareness. Learning that an aversive event can't be avoided nor escaped may result in a condition called learned helplessness. There is evidence for human behavioral learning prenatally, in which habituation has been observed as early as 32 weeks into gestation, indicating that the central nervous system is sufficiently developed and primed for learning and memory to occur very early on in development.

Play has been approached by several theorists as a form of learning. Children experiment with the world, learn the rules, and learn to interact through play. Lev Vygotsky agrees that play is pivotal for children's development, since they make meaning of their environment through playing educational games. For Vygotsky, however, play is the first form of learning language and communication and the stage where a child begins to understand rules and symbols. This has led to a view that learning in organisms is always related to semiosis.

1.11 TYPES OF MEMORY

1.11.1 Semantic Memory

Semantic memory refers to a portion of long-term memory that processes ideas and concepts that are not drawn from personal experience. Semantic memory includes things that are common knowledge, such as the names of colors, the sounds of letters, the capitals of countries and other basic facts acquired over a lifetime.

The concept of semantic memory is fairly new. It was introduced in 1972 as the result of collaboration between Endel Tulving of the University of Toronto and Wayne Donaldson of the University of New Brunswick on the impact of organization in human memory.

Tulving outlined the separate systems of conceptualization of episodic and semantic memory in his book, "Elements of Episodic Memory." He noted that semantic and episodic differ in how they operate and the types of information they process.

Before Tulving, human memory had not undergone many in-depth studies or research. Since then, a number of research projects have investigated the differences between semantic and episodic memory. Some of the most notable experiments relating to semantic memory were conducted by J.F. Kihlstrom in the 1980s to test hypnosis on semantic and episodic memory.

1.11.2 Episodic Memory

Episodic memory is a person's unique memory of a specific event, so it will be different from someone else's recollection of the same experience.

Episodic memory is sometimes confused with autobiographical memory, and while autobiographical memory involves episodic memory, it also relies on semantic memory. For example, you know the city you were born in and the date, although you don't have specific memories of being born.

Forming an episodic memory involves several unique steps, each of which involves a separate system of the brain. The first step in the process is called encoding, a process that your brain goes through each time you form a new episodic memory.

Another step in the process of forming an episodic memory is called consolidation, which is basically baking the event into your long-term memory. This helps the memory become more strongly ingrained so that it is not lost if the brain suffers an impairment. Episodic memory can be affected by trauma, hydrocephalus, tumors, metabolic conditions such as Vitamin B1 deficiency, and neurological diseases such as Alzheimer's disease.

The final process involves recollection. Recollection is a process that elicits the retrieval of contextual information pertaining to a specific incident. Sometimes a recollection from long-term memory is retrieved almost effortlessly, and other times it may need something to trigger it, such as a word, an image or even a smell.

Examples of episodic memory

People are usually able to associate particular details with an episodic memory, such as how they felt, the time and place, and other particulars. It is not completely understood why we remember certain instances in our life while others go unrecorded in our episodic memories. It is believed that emotion plays a key role in our formation of episodic memories.

Some examples of episodic memory:

- Where you were and the people you were with when you found out about the 9/11 attacks
- Your skiing vacation last winter
- The first time you traveled by airplane
- Your roommate from your first year in college
- The details about how you learned of a relative's death
- Fearing water because you were knocked over by a wave at the beach as a child
- Your first day at a new job
- Attending a relative's 75th birthday party
- Neighbors on the block where you grew up
- The movie you saw on your first date with your wife

1.11.3 Working Memory and long-term memory

Working memory is a cognitive system with a limited capacity that can hold information temporarily. Working memory is important for reasoning and the guidance of decision-making and behaviour. Working memory is often used synonymously with short-term memory, but some theorists consider the two forms of memory distinct, assuming that working memory allows for the manipulation of stored information, whereas short-term memory only refers to the short-term storage of information. Working memory is a theoretical concept central to cognitive psychology, neuropsychology, and neuroscience.

The term "working memory" was coined by Miller, Galanter, and Pribram, and was used in the 1960s in the context of theories that likened the mind to a computer. In 1968, Atkinson and Shiffrin used the term to describe their "short-term store". What we now call working memory was formerly referred to variously as a "short-term store" or short-term memory, primary memory, immediate memory, operant memory, and provisional memory. Short-term memory is the ability to remember information over a brief period (in the order of seconds). Most theorists today use the concept of working memory to replace or include the older concept of short-term memory, marking a stronger emphasis on the notion of manipulating information rather than mere maintenance.

The earliest mention of experiments on the neural basis of working memory can be traced back to more than 100 years ago, when Hitzig and Ferrier described ablation experiments of the prefrontal cortex (PFC); they concluded that the frontal cortex was important for cognitive rather than sensory processes. In 1935 and 1936, Carlyle Jacobsen and colleagues were the first to show the deleterious effect of prefrontal ablation on delayed response

Anders Ericsson and Walter Kintsch have introduced the notion of "long-term working memory", which they define as a set of "retrieval structures" in long-term memory that enable seamless access to the information relevant for everyday tasks. In this way, parts of long-term memory effectively function as working memory. In a similar vein, Cowan does not regard working memory as a separate system from long-term memory. Representations in working memory are a subset of representations in long-term memory. Working memory is organized into two embedded levels. The first consists of long-term memory representations that are activated. There can be many of these—there is theoretically no limit to the activation of representations in long-term memory. The second level is called the focus of attention. The focus is regarded as having a limited capacity and holds up to four of the activated representations.

Oberauer has extended Cowan's model by adding a third component, a narrower focus of attention that holds only one chunk at a time. The one-element focus is embedded in the four-element focus and serves to select a single chunk for processing. For example, four digits can be held in mind at the same time in Cowan's "focus of attention". When the individual wishes to perform a process on each of these digits—for example, adding the number two to each digit—separate processing is required for each digit since most individuals cannot perform several mathematical processes in parallel. Oberauer's attentional component selects one of the digits for processing and then shifts the attentional focus to the next digit, continuing until all digits have been processed.

1.11.4 Long Term Memory

Long-term memories are all the memories we hold for periods of time longer than a few seconds; long-term memory encompasses everything from what we learned in first grade to our old addresses to what we wore to work yesterday. Long-term memory has an incredibly vast storage capacity, and some memories can last from the time they are created until we die.

There are many types of long-term memory. Explicit or declarative memory requires conscious recall; it consists of information that is consciously stored or retrieved. Explicit memory can be further subdivided into semantic memory (facts taken out of context, such as “Paris is the capital of France”) and episodic memory (personal experiences, such as “When I was in Paris, I saw the Mona Lisa”).

In contrast to explicit/declarative memory, there is also a system for procedural/implicit memory. These memories are not based on consciously storing and retrieving information, but on implicit learning. Often this type of memory is employed in learning new motor skills. An example of implicit learning is learning to ride a bike: you do not need to consciously remember how to ride a bike, you simply do. This is because of implicit memory.

1.11.5 Emotion and Memory

Emotion can have a powerful effect on humans and animals. Numerous studies have shown that the most vivid autobiographical memories tend to be of emotional events, which are likely to be recalled more often and with more clarity and detail than neutral events.

The activity of emotionally enhanced memory retention can be linked to human evolution; during early development, responsive behavior to environmental events would have progressed as a process of trial and error. Survival depended on behavioral patterns that were repeated or reinforced through life and death situations. Through evolution, this process of learning became genetically embedded in humans and all animal species in what is known as flight or fight instinct.

Artificially inducing this instinct through traumatic physical or emotional stimuli essentially creates the same physiological condition that heightens memory retention by exciting neuro-chemical activity affecting areas of the brain responsible for encoding and recalling memory. This memory-enhancing effect of emotion has been demonstrated in many laboratory studies, using stimuli ranging from words to pictures to narrated slide shows, as well as autobiographical memory studies. However, as described below, emotion does not always enhance memory.

1.11.6 Learning

Learning is an adaptive function by which our nervous system changes in relation to stimuli in the environment, thus changing our behavioral responses and permitting us to function in our environment. The process occurs initially in our nervous system in response to environmental stimuli. Neural pathways can be strengthened, pruned, activated, or rerouted, all of which cause changes in our behavioral responses.

Instincts and reflexes are innate behaviors—they occur naturally and do not involve learning. In contrast, learning is a change in behavior or knowledge that results from experience. The field of behavioral psychology focuses largely on measurable behaviors that are learned, rather than trying to understand internal states such as emotions and attitudes.

Types of Learning

There are three main types of learning: classical conditioning, operant conditioning, and observational learning. Both classical and operant conditioning are forms of associative learning, in which associations are made between events that occur together. Observational learning is just as it sounds: learning by observing others.

Classical Conditioning

Classical conditioning is a process by which we learn to associate events, or stimuli, that frequently happen together; as a result of this, we learn to anticipate events. Ivan Pavlov conducted a famous study involving dogs in which he trained (or conditioned) the dogs to associate the sound of a bell with the presence of a piece of meat. The conditioning is achieved when the sound of the bell on its own makes the dog salivate in anticipation for the meat.

Operant Conditioning

Operant conditioning is the learning process by which behaviors are reinforced or punished, thus strengthening or extinguishing a response. Edward Thorndike coined the term "law of effect," in which behaviors that are followed by consequences that are satisfying to the organism are more likely to be repeated, and behaviors that are followed by unpleasant consequences are less likely to be repeated. B. F. Skinner researched operant conditioning by conducting experiments with rats in what he called a "Skinner box." Over time, the rats learned that stepping on the lever directly caused the release of food, demonstrating that behavior can be influenced by rewards or punishments. He differentiated between positive and negative reinforcement, and also explored the concept of extinction.

Observational Learning

Observational learning occurs through observing the behaviors of others and imitating those behaviors—even if there is no reinforcement at the time. Albert Bandura noticed that children often learn through imitating adults, and he tested his theory using his famous Bobo-doll experiment. Through this experiment, Bandura learned that children would attack the Bobo doll after viewing adults hitting the doll.

1.11.7 Habits (An Automatic Pilot)

Habit, in psychology, any regularly repeated behavior that requires little or no thought and is learned rather than innate. A habit—which can be part of any activity, ranging from eating and sleeping to thinking and reacting—is developed through reinforcement and repetition. Reinforcement encourages the repetition of a behaviors, or response, each time the stimulus that provoked the behaviors recurs. The behaviors become more automatic with each repetition. Some habits, however, may form on the basis of a single experience, particularly when emotions are involved. Habits, as discussed by William James in his Principles of Psychology, are useful as the means for conserving higher mental processes for more demanding tasks, but they promote behavioral inflexibility.

Five methods are commonly used to break unwanted habits: the replacement of the old response with a new response—e.g., eating fruit instead of candy to satisfy a craving for sweetness; the repetition of the behaviors until fatigue or another unpleasant response takes over—e.g., being forced to smoke cigarettes until nauseated so that a repulsion for cigarettes replaces the desire to smoke; the change of environment to separate the individual from the stimulus that is prompting the response; the gradual introduction of the stimulus that is provoking the behaviour—e.g., overcoming a child's fear of adult dogs by giving him a puppy; and punishment, which is probably the least effective method.

Types of Habits:

Habits are divided into three types depending upon the nature of activities.

1. Motor habits:

These habits refer to muscular activities of an individual. These are the habits related to our physical actions such as, standing, sitting, running, walking, doing exercise, maintaining particular postures of body, etc.

2. Intellectual habits:

These are the habits related to psychological process requiring our intellectual abilities such as good observation, accurate perception, logical thinking, using of reasoning ability before taking decisions and testing conclusions, etc.

3. Habits of character:

We express some of our characters in the form of habits. For example, helping others who are in need, trusting people, being honest, talking in a friendly way, time management, hardworking, keeping our dress clean and tidy, etc. These habits will have essence of feelings and emotions; hence these are also called as emotional habits.

1.12 CONSCIOUS AND UNCONSCIOUS BRAIN

1.12.1 Consciousness, Unconsciousness and the Rationality of Behaviour

Consciousness is the quality or state of being aware of an external object or something within oneself, such as thoughts, feelings, memories, or sensations. It has also been defined in the following ways: sentience, awareness, subjectivity, the ability to experience or to feel, wakefulness, having a sense of selfhood, and the executive-control system of the mind. At one time, consciousness was viewed with scepticism by many scientists, but in recent years, it has become a significant topic of research in psychology and neuroscience.

Despite the difficulty in coming to a definition, many philosophers believe that there is a broadly shared underlying intuition about what consciousness is. Philosophers since the time of Descartes and Locke have struggled to comprehend the nature of consciousness and pin down its essential properties. Issues of concern in the philosophy of consciousness include the following: whether consciousness can ever be explained mechanistically; whether non-human consciousness exists, and if so, how it can be recognized; how consciousness relates to language; whether consciousness can be understood in a way that does not require a dualistic distinction between mental and physical states or properties; and whether it may ever be possible for computers or robots to be conscious.

For over 2000 years, questions surrounding human consciousness—such as how the everyday inner workings of our brains give rise to a single cohesive reality and a sense of an individual self—have been baffling philosophers from Plato to Descartes. Descartes, as previously mentioned, is noted for his dualist theory of consciousness, in which the physical body is separate from the immaterial mind. He also gave us the most famous summary of human consciousness: “I think, therefore I am.”

The historical materialism of Karl Marx rejects the mind-body dichotomy, and holds that consciousness is engendered by the material contingencies of one’s environment. John Locke, another early philosopher, claimed that consciousness, and therefore personal identity, are independent of all substances. He pointed out that there is no reason to assume that consciousness is tied to any particular body or mind, or that consciousness cannot be transferred from one body or mind to another.

American psychologist William James compared consciousness to a stream—unbroken and continuous despite constant shifts and changes. While the focus of much of the research in psychology shifted to purely observable behaviors during the first half of the twentieth century, research on human consciousness has grown tremendously since the 1950s.

Today, the primary focus of consciousness research is on understanding what consciousness means both biologically and psychologically. It questions what it means for information to be present in consciousness, and seeks to determine the neural and psychological correlates of consciousness. Issues of interest include phenomena such as perception, subliminal perception, blindsight, anosognosia, brainwaves during sleep, and altered states of consciousness produced by psychoactive drugs or spiritual or meditative techniques.

The majority of experimental studies assess consciousness by asking human subjects for a verbal report of their experiences. However, in order to confirm the significance of these verbal reports, scientists must compare them to the activity that simultaneously takes place in the brain—that is, they must look for the neural correlates of consciousness. The hope is to find that observable activity in a particular part of the brain, or a particular pattern of global brain activity, will be strongly predictive of conscious awareness. Several brain-imaging techniques, such as EEG and fMRI scans, have been used for physical measures of brain activity in these studies.

Higher brain areas are more widely accepted as necessary for consciousness to occur, especially the prefrontal cortex, which is involved in a range of higher cognitive functions collectively known as executive functions.

Figure 1.25: Prefrontal cortex

Prefrontal cortex: This image shows the location of the prefrontal cortex, an area of the brain heavily involved in consciousness.

The unconscious mind (or the unconscious) consists of the processes in the mind which occur automatically and are not available to introspection and include thought processes, memories, interests and motivations.

Even though these processes exist well under the surface of conscious awareness, they are theorized to exert an effect on behavior. The term was coined by the 18th-century German Romantic philosopher Friedrich Schelling and later introduced into English by the poet and essayist Samuel Taylor Coleridge.

Empirical evidence suggests that unconscious phenomena include repressed feelings, automatic skills, subliminal perceptions, and automatic reactions, and possibly also complexes, hidden phobias and desires.

The concept was popularized by the Austrian neurologist and psychoanalyst Sigmund Freud. In psychoanalytic theory, unconscious processes are understood to be directly represented in dreams, as well as in slips of the tongue and jokes.

Thus, the unconscious mind can be seen as the source of dreams and automatic thoughts (those that appear without any apparent cause), the repository of forgotten memories (that may still be accessible to consciousness at some later time), and the locus of implicit knowledge (the things that we have learned so well that we do them without thinking).

It has been argued that consciousness is influenced by other parts of the mind. These include unconsciousness as a personal habit, being unaware and intuition. Phenomena related to semi-consciousness include awakening, implicit memory, subliminal messages, trances, hypnagogic and hypnosis. While sleep, sleepwalking, dreaming, delirium and comas may signal the presence of unconscious processes, these processes are seen as symptoms rather than the unconscious mind itself.

1.13 EMOTIONS AND MOTIVATIONS

An emotion is a mental and physiological feeling state that directs our attention and guides our behaviors. Whether it is the thrill of a roller-coaster ride that elicits an unexpected scream, the flush of embarrassment that follows a public mistake, or the horror of a potential plane crash that creates an exceptionally brilliant response in a pilot, emotions move our actions. Emotions normally serve an adaptive role: We care for infants because of the love we feel for them, we avoid making a left turn onto a crowded highway because we fear that a speeding truck may hit us, and we are particularly nice to Mandy because we are feeling guilty that we did not go to her party. But emotions may also be destructive, such as when a frustrating experience leads us to lash out at others who do not deserve it.

The Surrey School District in British Columbia has incorporated "emotional regulation" into the curriculum. In six schools, educators are piloting a program that helps teachers look for what may be stressing children, making them unable to pay attention, lethargic, hyperactive, or out of control. The children may be impacted by too much noise in the classroom, too little sleep, or too much junk food in their lunch. The teachers help the children recognize what they need to do to make themselves calm and productive in class. The program ultimately places the motivation for behavioural control within the hands of the children.

Motivations are closely related to emotions. A motivation is a driving force that initiates and directs behaviors. Some motivations are biological, such as the motivation for food, water, and sex. But there are a variety of other personal and social motivations that can influence behaviour, including the motivations for social approval and acceptance, the motivation to achieve, and the motivation to take, or to avoid taking, risks. In each case we follow our motivations because they are rewarding. As predicted by basic theories of operant learning, motivations lead us to engage in particular behaviours because doing so makes us feel good.

Motivations are often considered in psychology in terms of drives, which are internal states that are activated when the physiological characteristics of the body are out of balance, and goals, which are desired end states that we strive to attain. Motivation can thus be conceptualized as a series of behavioural responses that lead us to attempt to reduce drives and to attain goals by comparing our current state with a desired end state. Like a thermostat on an air conditioner, the body tries to maintain homeostasis, the natural state of the body's systems, with goals, drives, and arousal in balance. When a drive or goal is aroused—for instance, when we are hungry—the thermostat turns on and we start to behave in a way that attempts to reduce the drive or meet the goal (in this case to seek food). As the body works toward the desired end state, the thermostat continues to check whether or not the end state has been reached. Eventually, the need or goal is satisfied (we eat), and the relevant behaviours are turned off. The body's thermostat continues to check for homeostasis and is always ready to react to future needs.

In addition to more basic motivations such as hunger, a variety of other personal and social motivations can also be conceptualized in terms of drives or goals. When the goal of studying for an exam is hindered because we take a day off from our schoolwork, we may work harder on our studying on the next day to move us toward our goal. When we are dieting, we may be more likely to have a big binge on a day when the scale says that we have met our prior day's goals. And when we are lonely, the motivation to be around other people is aroused and we try to socialize. In many, if not most cases, our emotions and motivations operate out of our conscious awareness to guide our behaviors.

We begin considering the role of effect on behaviors, discussing the most important psychological theories of emotions. Then we will consider how emotions influence our mental and physical health. We will discuss how the experience of long-term stress causes illness, and then turn to research on positive thinking and what has been learned about the beneficial health effects of more positive emotions. Finally, we will review some of the most important human motivations, including the behaviors of eating and sex. The importance of this chapter is not only in helping you gain an understanding the principles of affect but also in helping you discover the important roles that affect plays in our everyday lives, and particularly in our mental and physical health. The study of the interface between affect and physical health — that principle that "everything that is physiological is also psychological" — is a key focus of the branch of psychology known as health psychology. The importance of this topic has made health psychology one of the fastest growing fields in psychology.

1.14 EMOTIONAL AROUSAL

Emotional Arousal is a state of heightened physiological activity. This includes having strong emotions like anger and fear and we go to the emotional arousal state in response to our daily experiences. For example, the fight, flight or freeze response is a state of emotional arousal.

Some people come into this world with their emotional arousal response on high alert. For others it takes a lot to trigger their emotional arousal response. However, we come into this world, our emotional arousal isn't set in stone. It develops throughout our life. Arousal starts with a Nature component as a hardwired response to our experiences. That emotional arousal then develops over time as a reaction to a lifetime of experiences.

There are a number of factors that influence the development of our emotional arousal, including Attachment Styles and Relational Feedback Loops

1.14.1 Motivation

A second biological approach to the study of human motivation has been the study of mechanisms that change the arousal level of the organism. Early research on this topic emphasized the essential equivalency of changes in arousal, changes in emotion, and changes in motivation. It was proposed that emotional expressions and the motivation of behaviour are the observable manifestations of changes in arousal level. One of the earliest arousal theories suggested that one's perception of emotion depends upon the bodily responses the individual makes to a specific, arousing situation. This theory became known as the James-Lange theory of emotion after the two researchers, William James and the Danish physician Carl Lange, who independently proposed it in 1884 and 1885 respectively. The theory argued, for example, that experiencing a dangerous event such as an automobile accident leads to bodily changes such as increased breathing and heart rate, increased adrenaline output, and so forth. These changes are detected by the brain and the emotion appropriate to the situation is experienced. In the example of the automobile accident, fear might be experienced as a result of these bodily changes.

1.15 BRAIN RESEARCH METHODS

1.15.1 Lesion Studies

Studying the effects of brain lesions on behavior and cognition is one of the most established and influential methods in neuroscience. In the 19th century, case studies of patients with focal brain damage provided the first evidence that complex cognitive processes, such as those underlying language, have dissociable components that depend on different regions of the brain. Brain lesion studies constituted the foundation of cognitive neuroscience that emerged in the mid to late 20th century. This included seminal work such as Brenda Milner's demonstration that memory, like language, involves distinct component processes with their own neural substrates, as well as the work of Mortimer Mishkin and Leslie Ungerleider on the dissociable contributions of the dorsal and ventral visual pathways in nonhuman primates (NHPs; see Glossary). These investigations helped to inspire decades of influential new ideas: cognitive theories, intrepid studies of neural activity, and new models of brain function. Studies of subjects with focal lesions have since continued to provide fundamental insights in the fields of learning, cognitive control, social behavior, memory, and more.

The advent of new neural manipulation methods, both invasive (e.g., optogenetics, chemo genetics) and noninvasive (e.g., transcranial magnetic stimulation, TMS; transcranial focal ultrasound), and the explosion of increasingly sophisticated functional neuroimaging methods, such as positron emission tomography (PET), functional magnetic resonance imaging (fMRI), and electrophysiological measures of neural activity, calls for a critical re-examination of the strengths and limitations of chronic, focal lesion studies. The purpose of this article is to evaluate the role of lesion methods as they relate to other causal and correlative methods in the toolkit of contemporary cognitive and systems neuroscience. Specifically, we discuss four topics: (i) inferences that can be made from lesion studies compared to other methods, (ii) combining lesion studies with correlative methods, (iii) recent advances in lesion methods, and (iv) lesion studies outside the laboratory. Although many of the points raised here may apply to other animal models, we focus on evidence from humans and NHP lesion studies given the similarities between the neuroanatomy of NHPs and humans in terms of cortical expansion and topographical connections (e.g., corticocortical and corticobasal ganglia pathways). Our goal in focusing on humans and NHPs is to highlight the similarities of lesion findings in these models and to emphasize how invasive lesion studies in NHPs have been essential in filling inferential gaps in this work. We conclude that (i) chronic lesion studies provide unique, vital insights into brain function that cannot be achieved via temporary inactivation methods or correlational studies of brain activity, and (ii) integrating insights gleaned from lesion studies with results from other methods is crucial for advancing neuroscience.

1.15.2 MRI

Magnetic resonance imaging (MRI) systems provide highly detailed images of tissue in the body. The systems detect and process the signals generated when hydrogen atoms, which are abundant in tissue, are placed in a strong magnetic field and excited by a resonant magnetic excitation pulse.

Hydrogen atoms have an inherent magnetic moment as a result of their nuclear spin. When placed in a strong magnetic field, the magnetic moments of these hydrogen nuclei tend to align. Simplistically, one can think of the hydrogen nuclei in a static magnetic field as a string under tension. The nuclei have a resonant or "Larmor" frequency determined by their localized magnetic field strength, just as a string has a resonant frequency determined by the tension on it. For hydrogen nuclei in a typical 1.5T MRI field, the resonant frequency is approximately 64MHz.

Figure 1.26: Magnetic resonance imaging (MRI)

Proper stimulation by a resonant magnetic or RF field at the resonant frequency of the hydrogen nuclei can force the magnetic moments of the nuclei to partially, or completely, tip into a plane perpendicular to the applied field. When the applied RF-excitation field is removed, the magnetic moments of the nuclei process in the static field as they realign. This realignment generates an RF signal at a resonant frequency determined by the magnitude of the applied field. This signal is detected by the MRI imaging system and used to generate an image.

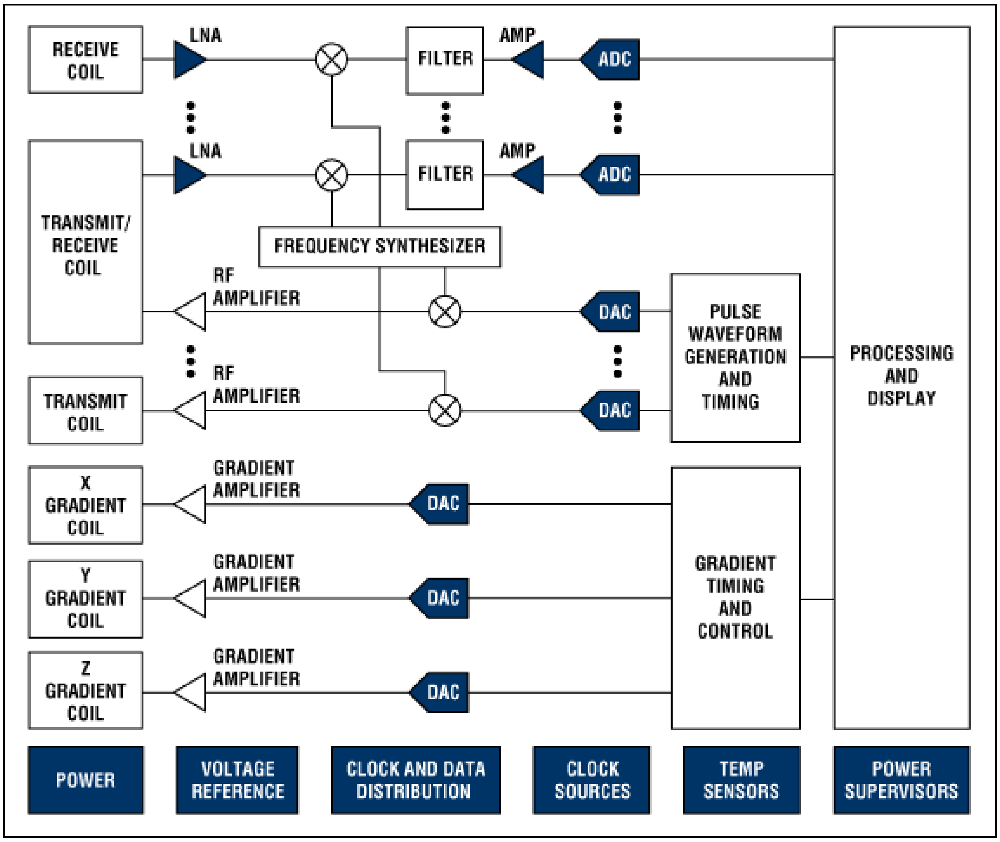


Figure 1.27: Block diagram of an MRI imaging system.

Static Magnetic Field

MRI imaging requires the patient to be placed in a strong magnetic field in order to align the hydrogen nuclei. There are typically three methods to generate this field: fixed magnets, resistive magnets (current passing through a traditional coil of wire), and super-conducting magnets. Fixed magnets and resistive magnets are generally restricted to field strengths below 0.4T and cannot generate the higher field strengths typically necessary for high-resolution imaging. As a result, most high-resolution imaging systems use super-conducting magnets. The super-conducting magnets are large and complex; they need the coils to be soaked in liquid Helium to reduce their temperature to a value close to absolute zero.

The magnetic fields generated by these methods must not only be strong, but also highly uniform in space and stable in time. A typical system must have less than 10ppm variation over the imaging area. To achieve this accuracy, most systems generate weaker static magnetic fields using specialized shim coils to "shim" or "tweak" the static field from the super conductor and thereby correct for field inaccuracies.

Gradient Coils

To produce an image, the MRI system must first stimulate hydrogen nuclei in a specific 2D image plane in the body, and then determine the location of those nuclei within that plane as they process back to their static state. These two tasks are accomplished using gradient coils which cause the magnetic field within a localized area to vary linearly as a function of spatial location. As a result, the resonant frequencies of the hydrogen nuclei are spatially dependent within the gradient. Varying the frequency of the excitation pulses controls the area in the body that is to be stimulated. The location of the stimulated nuclei as they process back to their static state can also be determined by using the emitted resonant RF-frequency and phase information.

An MRI system must have x, y, and z gradient coils to produce gradients in three dimensions and thereby create an image slice over any plane within the patient's body. The application of each gradient field and the excitation pulses must be properly sequenced, or timed, to allow the collection of an image data set. By applying a gradient in the z direction, for example, one can change the resonant frequency required to excite a 2D slice in that plane. Therefore, the spatial location of the 2D plane to be imaged is controlled by changing the excitation frequency. After the excitation sequence is complete, another properly applied gradient in the x direction can be used to spatially change the resonant frequency of the nuclei as they return to their static position. The frequency information of this signal can then be used to locate the position of the nuclei in the x direction. Similarly, a gradient field properly applied in the y direction can be used to spatially change the phase of the resonant signals and, hence, be used to detect the location of the nuclei in the y direction. By properly applying gradient and RF-excitation signals in the proper sequence and at the proper frequency, the MRI system maps out a 3-D section of the body.

To achieve adequate image quality and frame rates, the gradient coils in the MRI imaging system must rapidly change the strong static magnetic field by approximately 5% in the area of interest. High-voltage (operating at a few kilovolts) and high-current (100s of amps) power electronics are required to drive these gradient coils. Notwithstanding the large power requirements, low noise and stability are key performance metrics since any ripple in the coil current causes noise in the subsequent RF pickup.

That noise directly affects the integrity of the images.

To differentiate tissue types, the MRI systems analyze the magnitude of the received signals. Excited nuclei continue to radiate a signal until the energy absorbed during the excitation phase has been released. The time constant of these exponentially decaying signals ranges from tens of milliseconds to over a second; the recovery time is a function of field strength and the type of tissue. It is the variations in this time constant that allow different tissue types to be identified.

Transmit/Receive Coils

Transmit and receive coils are used both to stimulate the hydrogen nuclei and to receive the signals generated as the nuclei recover. These coils must be optimized for the particular body area to be imaged, so they are available in a wide variety of configurations. Depending on the area of the body to be imaged, either separate transmit and receive coils or combined transmit/receive coils are used. In addition, to improve image acquisition times, MRI systems use multiple transmit/receive coils to recover more information in parallel, thus utilizing the spatial information associated with the location of the coils.

RF Receiver

An RF receiver is used to process the signals from the receiver coils. Most modern MRI systems have six or more receivers to process the signals from multiple coils. The signals range from approximately 1MHz to 300MHz, with the frequency range highly dependent on applied-static magnetic field strength. The bandwidth of the received signal is small, typically less than 20kHz, and dependent on the magnitude of the gradient field.

A traditional MRI receiver configuration has a low-noise amplifier (LNA) followed by a mixer. The mixer mixes the signal of interest to a low-frequency IF frequency for conversion by a high-resolution, low-speed, 12-bit to 16-bit analog-to-digital converter (ADC). In this receive architecture, the ADCs used have relatively low sample rates below 1MHz. Because of the low-bandwidth requirements, ADCs with higher 1MHz to 5MHz sample rates can be used to convert multiple channels by time-multiplexing the receive channels through an analog multiplexer into a single ADC.

With the advent of higher-performance ADCs, newer receiver architectures are now possible. High-input-bandwidth, high-resolution, 12-bit to 16-bit ADCs with samples rates up to 100MHz can also be used to directly sample the signals, thereby eliminating the need for analog mixers in the receive chain.

Transmitter

The MRI transmitter generates the RF pulses necessary to resonate the hydrogen nuclei. The range of frequencies in the transmit excitation pulse and the magnitude of the gradient field determine the width of the image slice. A typical transmit pulse will produce an output signal with a relatively narrow ±1kHz bandwidth. The time-domain waveform required to produce this narrow frequency band typically resembles a traditional sync function. This waveform is usually generated digitally at baseband and then upconverted by a mixer to the appropriate center frequency. Traditional transmit implementations require relatively low-speed digital-to-analog converters (DACs) to generate the baseband waveform, as the bandwidth of this signal is relatively small.

Again, with recent advances in DAC technology other potential transmit architectures are achievable. Very-high-speed, high-resolution DACs can be utilized for direct RF generation of transmit pulses up to 300MHz. Waveform generation and upconversion over a broad band of frequencies can, therefore, now be accomplished in the digital domain.

Image Signal Processing

Both frequency and phase data are collected in what is commonly referred to as the k-space. A two-dimensional Fourier transform of this k-space is computed by a display processor/computer to produce a Gray-scale image.

1.15.3 fMRI

FMRI is one of the most recently developed forms of neuroimaging but the idea underpinning the technique - inferring brain activity by measuring changes in blood flow - is not new. The following account of an experiment performed by the Italian scientist Angelo Mosso (left) can be found in William James' the Principles of Psychology, published in 1890:

'The subject to be observed lay on a delicately balanced table which could tip downwards either at the head or the foot if the weight of either end was increased. The moment emotional or intellectual activity began in the subject, down went the balance at the head-end, in consequence of the redistribution of blood in his system…'

The reported success of this early experiment can only have been wishful thinking on the investigator's behalf. But the suggestion that blood flow is coupled to neural activity was insightful. In 1890 the prevailing view was that since the brain is encased by the skull, local increases in blood flow and volume would be impossible. It was thought instead that any changes in blood flow were caused by systemic changes in blood pressure or cardiac output.

Toward the end of the nineteenth century, Charles S. Roy and Charles S. Sherrington provided the first evidence supporting a coupling between energy metabolism and blood flow in the brain. In their experiments, a monitoring device was placed on the brain surface of anesthetized dogs, which measured fluctuations in blood volume (Sherrington Starling kymograph, left). They showed that blood volume (and presumably flow) does change locally in the brain. However, it was still unclear whether the brain itself was responsible for mediating these changes.

It was not until 1948 in a seminal experiment measuring oxygen metabolism and blood flow in the brain that Seymour Kety and Carl Schmidt confirmed that blood flow in the brain is regionally regulated by the brain itself. They demonstrated that when neurons use more oxygen, chemical signals cause nearby blood vessels to dilate. The increase in vascular volume leads to a local increase in blood flow. At the time of these publications Researchers were considered vascular physiologists more than brain scientists. Nevertheless, the ability to measure CBF, a proven correlate of brain metabolism, opened up the remarkable possibility of studying brain function in humans.

The development of FMRI in the 1990s, generally credited to Seiji Ogawa and Ken Kwong, is the latest in long line of innovations, including positron emission tomography (PET) and near infrared spectroscopy (NIRS), which use blood flow and oxygen metabolism to infer brain activity. As a brain imaging technique FMRI has several significant advantages:

- It is non-invasive and doesn't involve radiation, making it safe for the subject.
- It has excellent spatial and good temporal resolution.
- It is easy for the experimenter to use.

The attractions of FMRI have made it a popular tool for imaging normal brain function – especially for psychologists. Over the last decade it has provided new insight to the investigation of how memories are formed, language, pain, learning and emotion to name but a few areas of research. FMRI is also being applied in clinical and commercial settings.

1.15.4 Near Infrared Spectroscopy (NIRS)

NIR spectroscopy is used for the compositional, functional and sensory analysis of ingredients, intermediates and final products. It is deployed in food and feed, agricultural, dairy, pharmaceutical, and chemical industries, which are under constant pressure to manufacture products that meet non-consumer specifications while increasing plant production and profitability.

NIR can be used for quantitative analysis (determination of substance concentrations), qualitative analysis (identification of raw materials, intermediate and finished products) and process control. It can provide information on moisture, protein, fat and starch content. NIR application vary in each industry and are custom designed to suit different companies and their specific products and needs.

1.15.5 PET

Positron emission tomography (PET) is a functional imaging technique that uses radioactive substances known as radiotracers to visualize and measure changes in metabolic processes, and in other physiological activities including blood flow, regional chemical composition, and absorption. Different tracers are used for various imaging purposes, depending on the target process within the body. For example, 18F-FDG is commonly used to detect cancer, NaF-F18 is widely used for detecting bone formation, and oxygen-15 is sometimes used to measure blood flow.

PET is a common imaging technique, a medical scintillography technique used in nuclear medicine. A radiopharmaceutical—a radioisotope attached to a drug—is injected into the body as a tracer. Gamma rays are emitted and detected by gamma cameras to form a three-dimensional image, in a similar way that an X-ray image is captured.

PET scanners can incorporate a CT scanner and are known as PET-CT scanners. PET scan images can be reconstructed using a CT scan performed using one scanner during the same session.

One of the disadvantages of a PET scanner is its high initial cost and ongoing operating costs.

PET is both a medical and research tool used in pre-clinical and clinical settings. It is used heavily in the imaging of tumours and the search for metastases within the field of clinical oncology, and for the clinical diagnosis of certain diffuse brain diseases such as those causing various types of dementias. PET is a valuable research tool to learn and enhance our knowledge of the normal human brain, heart function, and support drug development. PET is also used in pre-clinical studies using animals. It allows repeated investigations into the same subjects over time, where subjects can act as their own control and substantially reduces the numbers of animals required for a given study. This approach allows research studies to reduce the sample size needed while increasing the statistical quality of its results.

Physiological processes lead to anatomical changes in the body. Since PET is capable of detecting biochemical processes as well as expression of some proteins, PET can provide molecular-level information much before any anatomic changes are visible. PET scanning does this by using radiolabelled molecular probes that have different rates of uptake depending on the type and function of tissue involved. Regional tracer uptake in various anatomic structures can be visualized and relatively quantified in terms of injected positron emitter within a PET scan.

PET imaging is best performed using a dedicated PET scanner. It is also possible to acquire PET images using a conventional dual-head gamma camera fitted with a coincidence detector. The quality of gamma-camera PET imaging is lower, and the scans take longer to acquire. However, this method allows a low-cost on-site solution to institutions with low PET scanning demand. An alternative would be to refer these patients to another center or relying on a visit by a mobile scanner.

Alternative methods of medical imaging include single-photon emission computed tomography (SPECT), x-ray computed tomography (CT), magnetic resonance imaging (MRI) and functional magnetic resonance imaging (fMRI), and ultrasound. SPECT is an imaging technique similar to PET that uses radioligands to detect molecules in the body. SPECT is less expensive and provides inferior image quality than PET.

1.15.6 Single Cell Recording

In neuroscience, single-unit recordings provide a method of measuring the electro-physiological responses of a single neuron using a microelectrode system. When a neuron generates an action potential, the signal propagates down the neuron as a current which flows in and out of the cell through excitable membrane regions in the soma and axon. A microelectrode is inserted into the brain, where it can record the rate of change in voltage with respect to time. These microelectrodes must be fine-tipped, low-impedance conductors; they are primarily glass micro-pipettes, metal microelectrodes made of platinum, tungsten, iridium or even iridium oxide. Microelectrodes can be carefully placed close to the cell membrane, allowing the ability to record extracellularly.

Single-unit recordings are widely used in cognitive science, where it permits the analysis of human cognition and cortical mapping. This information can then be applied to brain machine interface (BMI) technologies for brain control of external devices.

There are many techniques available to record brain activity—including electroencephalography (EEG), magneto encephalography (MEG), and functional magnetic resonance imaging (fMRI)—but these do not allow for single-neuron resolution. Neurons are the basic functional units in the brain; they transmit information through the body using electrical signals called action potentials. Currently, single-unit recordings provide the most precise recordings from a single neuron. A single unit is defined as a single, firing neuron whose spike potentials are distinctly isolated by a recording microelectrode.

The ability to record signals from neurons is centered around the electric current flow through the neuron. As an action potential propagates through the cell, the electric current flows in and out of the soma and axons at excitable membrane regions. This current creates a measurable, changing voltage potential within (and outside) the cell. This allows for two basic types of single-unit recordings. Intracellular single-unit recordings occur within the neuron and measure the voltage change (with respect to time) across the membrane during action potentials. This outputs as a trace with information on membrane resting potential, postsynaptic potentials and spikes through the soma (or axon). Alternatively, when the microelectrode is close to the cell surface extracellular recordings measure the voltage change (with respect to time) outside the cell, giving only spike information. Different types of microelectrodes can be used for single-unit recordings; they are typically high-impedance, fine-tipped and conductive. Fine tips allow for easy penetration without extensive damage to the cell, but they also correlate with high impedance. Additionally, electrical and/or ionic conductivity allow for recordings from both non-polarizable and polarizable electrodes. The two primary classes of electrodes are glass micropipettes and metal electrodes. Electrolyte-filled glass micropipettes are mainly used for intracellular single-unit recordings; metal electrodes (commonly made of stainless steel, platinum, tungsten or iridium) and used for both types of recordings.

Single-unit recordings have provided tools to explore the brain and apply this knowledge to current technologies. Cognitive scientists have used single-unit recordings in the brains of animals and humans to study behaviors and functions. Electrodes can also be inserted into the brain of epileptic patients to determine the position of epileptic foci. More recently, single-unit recordings have been used in brain machine interfaces (BMI). BMIs record brain signals and decode an intended response, which then controls the movement of an external device (such as a computer cursor or prosthetic limb).

1.15.7 EEG

The first known neurophysiologic recordings of animals were performed by Richard Caton in 1875. The advent of recording the electrical activity of human beings took another half century to occur. Hans Berger, a German psychiatrist, pioneered the EEG in humans in 1924. The EEG is an electrophysiological technique for the recording of electrical activity arising from the human brain. Given its exquisite temporal sensitivity, the main utility of EEG is in the evaluation of dynamic cerebral functioning. EEG is particularly useful for evaluating patients with suspected seizures, epilepsy, and unusual spells. With certain exceptions, practically all patients with epilepsy will demonstrate characteristic EEG alterations during an epileptic seizure (ictal, or during-seizure, recordings). Most epilepsy patients also show characteristic interictal (or between-seizure) epileptiform discharges (IEDs) termed spike (<70 μsec duration), spike and wave, or sharp-wave (70–200 μsec duration) discharges.

EEG has also been adopted for several other clinical indications. For example, EEG may be used to monitor the depth of anesthesia during surgical procedures; given its great sensitivity in showing sudden changes in neural functioning even as they first occur, it has proven quite helpful in this setting in monitoring for potential complications such as ischemia or infarction. EEG waveforms may also be averaged, giving rise to evoked potentials (EPs) and event-related potentials (ERPs), potentials that represent neural activity of interest that is temporally related to a specific stimulus. EPs and ERPs are used in clinical practice and research for analysis of visual, auditory, somatosensory, and higher cognitive functioning.

The EEG is thought to be primarily generated by cortical pyramidal neurons in the cerebral cortex that are oriented perpendicularly to the brain's surface. The neural activity detectable by the EEG is the summation of the excitatory and inhibitory postsynaptic potentials of relatively large groups of neurons firing synchronously. Conventional scalp or cortical surface–recorded EEG is unable to register the momentary local field potential changes arising from neuronal action potentials. Please see Appendix 1 for further details on neurophysiologic principles underlying the EEG.

An unfortunate reality of EEG is that cerebral activity may be overwhelmed by other electrical activity generated by the body or in the environment. To be seen on the scalp surface, the miniscule, cerebrally generated EEG voltages must first pass through multiple biological filters that both reduce signal amplitude and spread the EEG activity out more widely than its original source vector. Cerebral voltages must traverse the brain, CSF, meninges, the skull, and skin prior to reaching the recording site where they can be detected. Additionally, other biologically generated electrical activity (by scalp muscles, the eyes, the tongue, and even the distant heart) creates massive voltage potentials that frequently overwhelm and obscure the cerebral activity. Temporary detachments of the recording electrodes (called “electrode pop” artifact) can further erode the EEG, or even imitate brain rhythms and seizures. The bottom line is that biological and environmental electrical artifacts frequently interfere with the interpreter's ability to accurately identify both normal rhythms and pathological patterns. Fortunately, artifacts possess many distinguishing characteristics that are readily identifiable by well-trained, careful observers.

A typical EEG display graphs voltages on the vertical domain and time on the horizontal domain, providing a near real-time display of ongoing cerebral activity (Figure 1). With digital recording and review, the interpreter can change several aspects of the EEG display for convenience and intelligibility of the data. The interpreter is able to adjust the sensitivity (also known as [aka] “gain”) of the recording, in microvolts per millimeter, to either increase or reduce the display height of waveforms. One may also alter the amount of time displayed, which is sometimes referred to as an epoch and used to be known as “paper speed.” Shorter intervals can be viewed with a few seconds on a computer screen, a distinct advantage for viewing very brief EEG events such as epileptiform spikes. Conversely, the time scale may be expanded to display longer segments of EEG over several minutes to look at slowly evolving rhythmic discharges. Digital filters may also be applied to reduce artifact in certain settings but must be used with great caution since they also filter EEG activity of interest and may distort EEG waveforms severely.

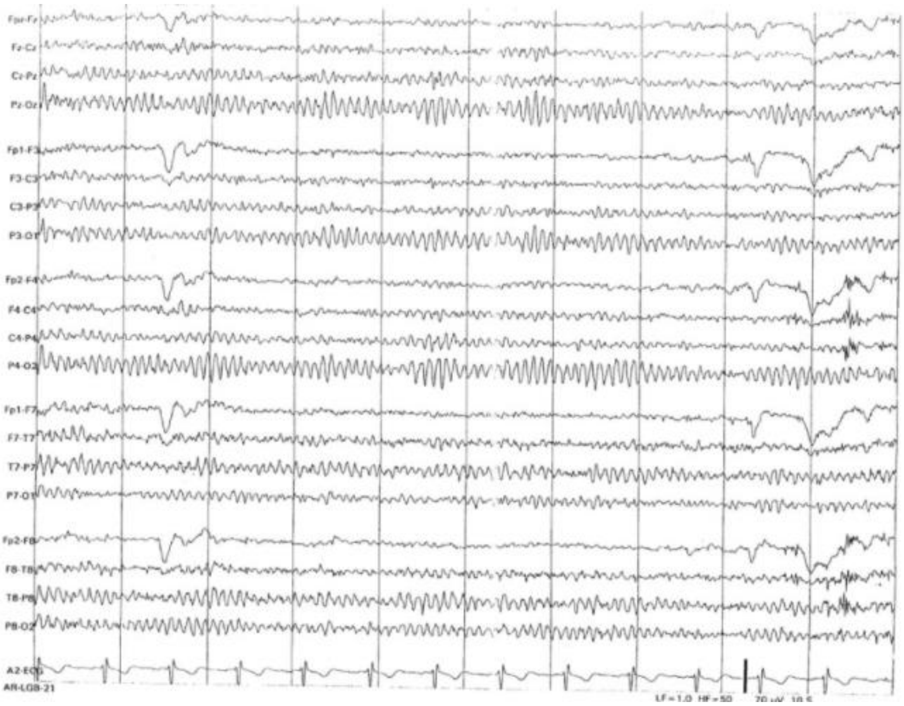


Figure 1.28: Normal EEG with typical montage.

An example of the EEG recorded during wakefulness in a 24-year-old woman. This is a 10-second duration epoch. The first four channels, together referred to as a chain, show cerebral activity recorded from the midline head region and by convention are arranged front to back. The next four channels, the second chain, show activity over the left parasagittal head region. The middle four channels, the third chain, shows the corresponding right parasagittal region. The two bottom sets of four channels, or chains, each show the left and right temporal head regions, respectively. Each division shows 1 second of recording time. There is faster sinusoidal rhythmic activity that is most prominent in each set of four channels over the occipital regions or posterior channels and is approximately symmetric. This is the PDR, best seen when the eyes are closed during relaxed wakefulness. The broadly contoured, downward deflection in the 2nd second in each of the five frontal channels represents an eye-blink artifact, as does the similar wave in the 9th second. An ECG channel is displayed at the very bottom, which helps the interpreter to detect the cardiac cycle (a common source of artifacts contaminating the EEG channels) and possible cardiac dysrhythmias. Copyright 2013. Mayo Foundation for Medical Education and Research. All rights reserved. Figure courtesy of Erik K. St. Louis, MD.

EEG uses the principle of differential amplification, or recording voltage differences between different points using a pair of electrodes that compares one active exploring electrode site with another neighboring or distant reference electrode. Only through measuring differences in electrical potential are discernible EEG waveforms generated. By convention, when the active exploring electrode (termed G1, for "Grid 1," a historical convention from analog amplification) is more negative than the reference electrode (G2), the EEG potential is directed above the horizontal meridian (i.e., an upward wave), whereas if the opposite is true, where the reference electrode is more negative, the EEG potential vector is directed below the horizontal meridian (downward potential). Other polarity possibilities are shown in Figure 2.

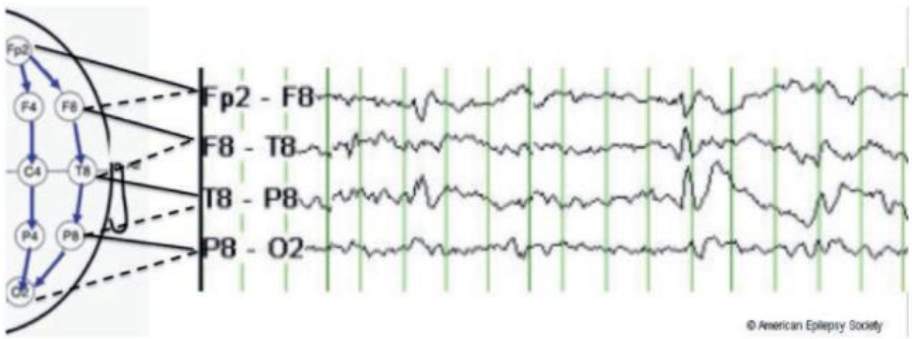


Figure 1.29: Polarity conventions and localization in EEG. An upward deflection is surface negative, and a downward deflection is surface positive

1.15.8 ERP

Exposure Response Prevention, commonly referred to as ERP, is a therapy that encourages you to face your fears and let obsessive thoughts occur without 'putting them right' or 'neutralizing' them with compulsions.

Exposure therapy starts with confronting items and situations that cause anxiety, but anxiety that you feel able to tolerate. After the first few times, you will find your anxiety does not climb as high and does not last as long.

You will then move on to more difficult exposure exercises.

ERP is by far the most commonly used therapy in many other parts of the world, but here in the UK the treatment recommended is Cognitive Behavioral Therapy**.** The behavioral aspect of CBT naturally includes elements of ERP but in addition, CBT also offers the benefit of cognitive therapy, so is a far more in-depth package than ERP alone.

1.15.9 MEG

Magnetoencephalography (MEG) is a functional neuroimaging technique for mapping brain activity by recording magnetic fields produced by electrical currents occurring naturally in the brain, using very sensitive magnetometers. Arrays of SQUIDs (superconducting quantum interference devices) are currently the most common magnetometer, while the SERF (spin exchange relaxation-free) magnetometer is being investigated for future machines. Applications of MEG include basic research into perceptual and cognitive brain processes, localizing regions affected by pathology before surgical removal, determining the function of various parts of the brain, and neurofeedback. This can be applied in a clinical setting to find locations of abnormalities as well as in an experimental setting to simply measure brain activity.

Synchronized neuronal currents induce weak magnetic fields. The brain's magnetic field, measuring at 10 femtotesla (fT) for cortical activity and 10^3 fT for the human alpha rhythm, is considerably smaller than the ambient magnetic noise in an urban environment, which is on the order of 10^8 fT or 0.1 μT. The essential problem of biomagnetism is, thus, the weakness of the signal relative to the sensitivity of the detectors, and to the competing environmental noise.

The MEG (and EEG) signals derive from the net effect of ionic currents flowing in the dendrites of neurons during synaptic transmission. In accordance with Maxwell's equations, any electrical current will produce a magnetic field, and it is this field that is measured. The net currents can be thought of as current dipoles, i.e. currents with a position, orientation, and magnitude, but no spatial extent. According to the right-hand rule, a current dipole gives rise to a magnetic field that points around the axis of its vector component.

To generate a signal that is detectable, approximately 50,000 active neurons are needed. Since current dipoles must have similar orientations to generate magnetic fields that reinforce each other, it is often the layer of pyramidal cells, which are situated perpendicular to the cortical surface, that gives rise to measurable magnetic fields. Bundles of these neurons that are orientated tangentially to the scalp surface project measurable portions of their magnetic fields outside of the head, and these bundles are typically located in the sulci. Researchers are experimenting with various signal processing methods in the search for methods that detect deep brain (i.e., non-cortical) signal, but no clinically useful method is currently available.

It is worth noting that action potentials do not usually produce an observable field, mainly because the currents associated with action potentials flow in opposite directions and the magnetic fields cancel out. However, action fields have been measured from peripheral nerves.

1.15.10 TMS

Transcranial magnetic stimulation (TMS) is a noninvasive procedure that uses magnetic fields to stimulate nerve cells in the brain to improve symptoms of depression. TMS is typically used when other depression treatments haven't been effective.

This treatment for depression involves delivering repetitive magnetic pulses, so it's called repetitive TMS or rTMS.

During an rTMS session, an electromagnetic coil is placed against your scalp near your forehead. The electromagnet painlessly delivers a magnetic pulse that stimulates nerve cells in the region of your brain involved in mood control and depression. It's thought to activate regions of the brain that have decreased activity in depression.

Though the biology of why rTMS works isn't completely understood, the stimulation appears to impact how the brain is working, which in turn seems to ease depression symptoms and improve mood.

There are different ways to perform the procedure, and techniques may change as experts learn more about the most effective ways to perform treatments.

Repetitive TMS is a noninvasive form of brain stimulation used for depression. Unlike vagus nerve stimulation or deep brain stimulation, rTMS does not require surgery or implantation of electrodes. And, unlike electroconvulsive therapy (ECT), rTMS doesn't cause seizures or require sedation with anesthesia.

Generally, rTMS is considered safe and well-tolerated. However, it can cause some side effects.

Common side effects

Side effects are generally mild to moderate and improve shortly after an individual session and decrease over time with additional sessions. They may include:

- Headache
- Scalp discomfort at the site of stimulation
- Tingling, spasms or twitching of facial muscles
- Lightheadedness

Your doctor can adjust the level of stimulation to reduce symptoms or may recommend that you take an over-the-counter pain medication before the procedure.

Uncommon side effects

Serious side effects are rare. They may include:

- Seizures
- Mania, particularly in people with bipolar disorder
- Hearing loss if there is inadequate ear protection during treatment

1.15.11 Eye Tracking

Eye tracking is the process of measuring either the point of gaze (where one is looking) or the motion of an eye relative to the head.

An eye tracker uses invisible near-infrared light and high-definition cameras to project light onto the eye and record the direction it’s reflected off the cornea. Advanced algorithms are then used to calculate the position of the eye and determine exactly where it is focused. This makes it possible to measure and study visual behavior and fine eye movements, as the position of the eye can be mapped multiple times a second. How quickly an eye tracker is able to capture these images is known as its frequency. A recording can also be made of the scene a person is looking at, and using eye tracking software it's possible to produce a visual map of how the person viewed elements of the scene.

In this blog post we will explore the range of eye trackers available, what types of research each is most suited to, how to understand and interpret the results of your eye tracking study, and the unique benefits of using eye tracking in research.

While the general principal of how they work is the same, there are several different eye tracking device types available and the one most appropriate for the user depends on the nature of their research. The main groups are:

- **Screen based –** These are stand-alone, remote devices which either come as an individual unit or a smaller panel which can be attached to a laptop or monitor.
- **Wearable –** These include eye tracking glasses and virtual reality (VR) headsets with integrated eye tracking.
- **Webcam –** Webcam eye trackers don't have sensors or specialized cameras; they are solely comprised of the webcam device attached or built-in to a computer.

1.15.12 Measure Ming of Physiological Responses

Physiological responses are the body's automatic reactions to a stimulus. Most of us are familiar with the automatic and instinctive physiological responses we experience every day, but we typically remain unaware of them. Many of us are also prone to more severe physiological responses to stimuli like stress that tap into what is known as the "fight or flight" response. When placed in a stressful situation, you might begin to sweat and your heart rate may increase, both types of physiological responses.

Physiological Responses to Phobias

Physiological responses happen when we perceive that we're under stress or danger, whether it's real or imagined. The fight or flight response is your body's way of protecting you by producing stress hormones, cortisol, and adrenaline so that you can be ready to either fight or run.

If you have a phobia, coming into contact with the object of your phobia can serve as the stress trigger for different types of physiological responses. Physiological response to an intense and irrational fear can manifest itself in physical ways, including:

- Dizziness
- Dry mouth
- Faster breathing
- Heart palpitations
- Nausea
- Panic attacks
- Shaking
- Sweating

Your physiological responses may be mild or severe, but they are not generally dangerous. However, these physical symptoms can mirror those of some medical conditions, so it's important to check with your doctor if you experience them.

Diagnosing a Phobia

In order for a phobia to be diagnosed, it must cause significant distress or interfere with your daily life. For example, a strong fear of snakes may not be a phobia for a city-dweller who would rarely come in contact with a snake. However, it may represent a severe phobia in a farmer whose country property is home to numerous snakes.

There are many anxieties and other disorders, such as generalized anxiety disorder, panic disorder, and post-traumatic stress disorder (PTSD) that can cause phobic-like reactions to certain situations. A mental health professional will do a comprehensive evaluation of your history and experiences to arrive at a correct diagnosis.

Treatment

Many phobias continue to worsen over time, so it's a good idea to get treated promptly. The two commonly accepted forms of treatment for phobias are medication and therapy. Many clinicians prefer to try therapy first, adding medications only if needed. Both types can help with the physiological responses caused by phobias.

Therapies

One of the most accepted forms of therapy for phobias is known as cognitive behavioral therapy (CBT). In CBT, your clinician works with you to confront the feared situation and change your phobic reaction by changing the automatic thoughts that occur.

Exposure therapy is a technique used in CBT that works well in treating phobias. A popular type is known as systematic desensitization during which you're gradually exposed to the feared object. You learn to tolerate increased exposure bit by bit.

Medications

In addition, prescription medications can help with physiological responses caused by phobias. These include antidepressants, anti-anxiety medications, and beta-blockers, which limit the effects of adrenaline on your body.

1.15.13 Face Reading

Over the years, the structure of the human body has undergone a transformation. These evolutionary processes are targeted at making the physical structure of the body adapt to external conditions.

Even more, few characteristics of the human body like the face, width, and height have almost become a subset of genetics in the modern era. Nevertheless, the face is the most prominent part that we present to the world and it is our face that speaks, smells, tastes, and listens. Hence, the four senses also play a key role in face reading.

First of all, the face is an emblem of expressions, emotions, and senses. Facial expressions are a gateway to a person's inner world and a vast array of emotions, feelings, and beliefs that the persons hold.

There are certified specialists, oftentimes common people also learn the skill of face reading. During our day-to-day interaction with people, we generally read faces and try to understand the underlying feelings and emotions of the person. And hence, sometimes false judgment or bias are likely to arise.

Firstly, we have to understand each aspect of the face and their connection with the intrinsic character or nature, one-by-one.

Eyes

- Deeper eyes represent introversion, toleration, pleasant, shy, and quiet nature.
- Protruding eyes show aggression, focus, attention, and intolerant nature.
- Less-distance between eyes represents focus and aim.
- More distance between eyes represents imagination and wavering thoughts.

Eyebrows

- Thick eyebrows represent greater imagination power and multiple ideas.
- Narrow eyebrows on the face mean fewer ideas.
- Eyebrows that point downwards at the end, show introversion and shyness
- Eyebrows that are straight show aggression and decisiveness.

Eyelashes

- Dense eyelashes show affection and compassionate feelings.
- Sparse eyelashes show insensitivity and lack of compassion.

Ears

- Ears that point outwards represents mastery in attack and defensiveness.
- If ears are closer to the head and not easily visible laterally, then it represents a conservative and calm nature.

Jaws

- Wider jaws represent masculinity, power, aggression, strength. However, they can be mentally and emotionally weak in nature sometimes.

- Small jaws represent mental strength and defensiveness.

Lips

- Thick lips represent talkativeness.
- Thin lips represent secretive and reluctant people.

Forehead

- A vertically wide forehead represents higher intellectual and thinking capability. On account of their prowess, the person can muster more wealth. These individuals generally possess higher attention to details than those with the vertically-narrow forehead.
- On the other hand, a horizontally wide forehead represents sharp thinking abilities. They have a broad spectrum of knowledge. Also, these individuals are great at multi-tasking.
- Similarly, a horizontally narrow forehead represents focus. These people are generally interested in gaining a specialization in only one or two domains. They are weak in multitasking. They are slow but very effective.

Nose

- Pointed/Narrow nose represents disinterest and lack of will.
- The wide nose represents knowledge and effective planning.
- Longnose represents managerial skills and leadership skills.
- Short/Small nose represents thinking, advisory skills and patience.

Mouth

- Wide mouth represents jolliness, happiness, fun-loving people.
- The narrow mouth represents shyness.

Chin

- Small chin represents calmness.

- Broad chin represents domination.

- Furthermore, people make a variety of expressions which are all unique. It depends upon what they are feeling at that particular moment.

Moreover, that would make multiple permutations and the combination of determining the motive.

1.15.14 Response Time Measures

Reaction time or response time refers to the amount of time that takes places between when we perceive something to when we respond to it**.** It is the ability to detect, process, and respond to a stimulus.

Reaction time depends on various factors:

- **Perception**: Seeing, hearing, or feeling a stimulus with certainty is essential to having good reaction time. When the starter shoots the gun at the beginning of a race, the sound is received by the athlete's ears (they perceive the stimulus).

- **Processing**: In order to have good reaction time, it's necessary to be focused and understand the information well. Following the previous example, the runners, after hearing the gun, will be able to distinguish the sound from other background noise and know that it is time to start running (process the stimulus).

- **Response**: Motor agility is necessary in order to be able to act and have good response time. When the runners perceived and correctly processes the signal, they started moving their legs (respond to the stimulus).

If any part of these processes is altered, reaction time will be affected as a consequence. In other words, if one of the athletes had poor reaction time, they would have a disadvantage against the other runners. Reaction time necessarily includes a motor component, unlike processing speed. This is why having good reaction time is associated with having good reflexes.

Examples of response time

- If you are driving and you come across a crosswalk, the time that it takes from when you see the crosswalk to when you break and stop the car would be reaction time. This cognitive ability can prevent us from many dangerous car accidents.

- In a boxing match or football game, it is very important to detect the opponents move and know what they're going to in order to react as quickly and carefully as possible. Good reaction time is the key to scoring and winning.

- A child is in gym class and has to start running when the teacher gives the signal. The time it takes between when the teacher gives the signal and when the child starts running would be reaction time.

- You're in a building and you smell smoke all of the sudden. Reaction time would be the time it takes you to find and use the closest fire extinguisher after detecting a fire.

- When a security guard sees suspicious behavior, the time that it takes him or her to react may be crucial for a successful intervention. If they see, for example, a robbery, response time would be the time between when they see the robbery and start taking action to prevent it.

How to measure and assess response time?

Reaction time plays a role in the majority of our day-to-day activities. Our ability to interact with out surroundings and react to unexpected changes and events depends directly on this cognitive skill. Being able to evaluate reaction time and understand how it functions could be very helpful in a variety of situations and areas. For example, academics, as it allows teachers or parents to understand if the child has perception, processing, or motor problems and the academic repercussions this may have, medical, as it can help detect mild problems in patients with perceptive, processing, or motor areas, or in the professional field, where it makes it possible for workers to know and understand if they are best prepared to carry out certain activities that may require them to act quickly in certain circumstances.

We are able to measure different cognitive functions, including reaction time, with a complete neuropsychological assessment. The tests that CogniFit created to measure reaction time were based on the classic NEPSY test, Test of Variables of Attention (TOVA), Continuous Performance Test (CPT), Test of Memory Malingering (TOMM), and the Visual Organization Task (VOT). Aside from measuring reaction time, these tests also measure working memory, visual scanning, hand-eye coordination, inhibition, cognitive flexibility, naming, visual perception, contextual memory, recognition, sustained attention, and spatial perception.

- Inquiry Test REST-COM: Objects will appear for a short period of time. The user must select the word that correspond the image as quickly as possible.

- Decoding Test VIPER-NAM: Images will appear on the screen for a short period of time and then disappear. Four letters will then appear, only one of which will correspond to the letter of the object. The user must choose the correct letter as quickly as possible.

- Recognition Test WOM-REST: A series of three objects will appear on the screen. The user must memorize the order in which they are displayed and later choose the correct order from a selection.

- Resolution Test REST-SPER: A number of moving stimuli will appear on the screen. The user must click on the objective stimuli while avoiding irrelevant stimuli.

- Speed Test REST-HECOOR: A blue square will appear on the screen. The user must click as quickly and as many times as possible in the middle of the square. The more times the user clicks, the higher the score.

- Processing Test REST-INH: In this task, two different sized blocks with numbers inside will appear. The user will first have to click on the bigger block. The next step is to click on the block with the highest number.

1.15.15 Bringing the Techniques Together

In modern day neuroscience, it’s easy to get confused over all the different neuromarketing techniques out there. While virtually all of the techniques used in the field can be valuable to marketing, it’s good to understand the difference between them and how they work.

Neuromarketing Technique 1: See Through Your Consumer’s Eyes With Eye Tracking

As the name suggests, eye tracking consists of measuring the eye movement patterns of your research participants. It's a tool that lets you see your brand, store or commercial through the eyes of your customers.

Because modern eye tracking equipment is very light and portable, it's possible to create real time scenarios and register the natural eye gaze of consumers.

How eye tracking is used? How about letting consumers take a walk in a retail store equipped with eye tracking gear to analyze how they view the store.

Do they look at the promotion articles near the entrance? Is the signage actually being read? What kind of viewing patterns do consumers show when browsing a product category? In short, eye tracking offers a great way to find out things that are hard to discover using traditional marketing research.

Besides in-store possibilities, eye tracking can measure the eye-gaze of consumers online as well. For example, it can be used to measure if product placement during TV programs actually makes people look more at a product.

Neuromarketing Technique 2: Taking A Look Within the Consumers' Brain: EEG And FMRI

If we want to know a bit more about what people think rather than what people see, there are some other techniques we could use. There are certain devices out there that you may know from a medical context that can read brain activity, such as fMRI and EEG equipment.

These brain scanners are nowadays used by neuromarketers to look at people's brains in order to create alluring ads, websites and packaging that press the customer's buy buttons. That might sound a bit unethical, but it's far less scary than it seems.

It just means that scientists can read, quite globally, if consumers like or not like a product, if they feel more like approaching or avoiding a product, or if they get excited or bored by a certain advertisement. Seems a lot like the kind of stuff you would ask in traditional marketing research, right? It just removes the process of deliberately thinking about the answers.

Nonetheless, this is very useful information for the marketer. It can help them create products that really speak to the consumer, and it can help consumers get products that make them happy.

Measuring these variables with EEG scans to analyze brainwaves provides great temporal resolution, meaning that the effects of a certain stimulus on brain activity can be read at incredible speed. For example, this is very useful to analyze which exact sequences in a commercial are viewed as positive and which ones are not.

However, it lacks good spatial resolution, meaning the source of the brain signal recorded by the EEG is hard to locate exactly in the brain. On the contrary, fMRI scans offer great spatial, but poor temporal resolution. This means we can see clearly what's happening inside the brain, but we don't really know what caused it.

Neuromarketing Technique 3: It's All In The Smile: Facial Coding

You don't have to peek into people's brain to measure what they truly feel. Science has shown us we can learn a lot from their faces too.

The idea that we can learn from our facial expressions is an old one, dating back to Charles Darwin in 1872. It has since been explored thoroughly by numerous psychologists; with important contributions coming from Paul Ekman. But how do we use this knowledge to our advantage in marketing?

In the same line as equipment to measure the brain and our eye gaze, there are also sensors that can be attached to the face and measure tiny movements of muscles. When we display certain emotions, like smiling, we use specific muscles to achieve this. The same principle applies to other emotions such as anger or surprise.

Of course, a slight expression of a faint smile does not always mean that someone is happy. But the point is, facial coding equipment can measure subtle, oftentimes subconscious, reactions to stimuli that hold information about how we feel about something. Even better, it can predict what behavior will follow said expressions.

Neuromarketing Technique 4: To Touch, Smell See and Hear: Sensory Marketing

In contrast to research-oriented methods like the ones we discussed above, there are more practical forms of neuromarketing that give consumers a little push in right direction. We can dip into existing findings and principles to make marketing more effective. A great example of this in the retail sphere is sensory marketing.

There are several forms of sensory marketing, such as touch, sound, or smell, and they aim to influence a brand audience by sensory stimulation. So, is it really possible that simply smelling something can make people buy more products? Sometimes.

With emotional products like the ones sold in a fashion store, a bit of pleasant smells will give customers a whole new experience and will make products seem more exclusive and higher end. However, fairly neutral environments like hardware or office retail shops are better off limiting noticeable smells.

And how about sound? As it turns out, consumers will pay more attention to light objects when they hear more high-pitched sounds, and more to dark objects when hearing low pitched sounds. Studies have discovered that these subtle changes in the in-store environment can have quite dramatic impacts on sales.

Neuromarketing Technique 5: Mind Tricks? Psychological Methods

While all the methods mentioned above might seem a bridge to far for the average marketing professional, there are also some purely psychological 'tricks' that will give the brand audience that little push that's often needed to make a sale.

Psychological techniques can be quite subtle. A speaking example, though perhaps more commonly known these days, is that merely removing the dollar sign listed for your products can increase your sales. Seeing a dollar sign – or for the European reader, a euro sign – subconsciously shifts people's attention to loss and not gain.

Of course, we do get something we want in return for our hard-earned euros or dollars, but it's still a bit unpleasant that we're spending money in the first place. Removing the sign really works too, as studies have found that people spend significantly more cash on products and food when a money sign is absent.

There are many nudges like these that influence people in very subtle ways. Did you know that people are more likely to choose healthy menu options when displayed on the left side of the menu and unhealthy items on the right? Or that large, open spaces in luxury stores are associated with high social status?

All of the methods discussed above offer useful and valuable tools and insights to neuromarketers. But not all methods are effective in all contexts. The key is knowing when to use which techniques. To learn more actionable insights about neuromarketing, how to use them, and to stay updated on the newest trends in field, be sure to subscribe to New Neuromarketing.

Chapter 2

DECODING PERSUASION SCIENCE

2.1 WHY IS NEUROMARKETING A GAME CHANGER?

The success mantra for businesses being non-consumer delight, understanding consumer behaviors has become an essential part for an organization to sustain in the long-run. The businesses surpassing the expectations of the consumers are standing out and tasting success. So, what are these companies doing different? Brands like Coca-Cola, Amazon, Google, Disney, Hyundai and many more in this list have adopted Neuromarketing techniques to understand the consumer behaviors.

Neuromarketing is a field of marketing which uses medical technologies such as EEG (Electroencephalogram) and fMRI (Functional Magnetic Resonance Imaging) to study the consumer behaviors through brain responses to the marketing stimuli shown by the marketer. In simple words it is a brain-based approach that helps marketers understand the underlying thoughts, feelings and intentions. Consumers make 90% of their decisions using subconscious mind, therefore when using a traditional method of interview, the respondent might not be aware of what she/he has registered subconsciously and might only be able to give a few instances from their recollection. But these technologies help marketers learn on what basis a consumer is making decisions and what triggers the brain which lets them press the buy button for a product.

To stay ahead in the race, marketers are crafting their ad campaigns on the basis of the insights they draw using Neuromarketing techniques. Various techniques used by marketers include eye tracking, brain mapping, sensory marketing and facial coding to understand the reaction of the human brain. Few of the most important stimuli that can be drawn are the attention, the emotional, the valuation (decision-making) and the retention stimuli. The best part of it is that most individuals give a similar kind of response to the stimuli and which help marketers articulate the findings accurately from these tests.

The famous Pepsi Challenge is the most used case to demonstrate

Neuromarketing. The participants were blindfolded and were given Coke and Pepsi and were asked which tasted better, over 51% responded Pepsi was better. The same participants were then given this challenge without blindfolds, to the surprise over 75% of the respondents chose Coke over Pepsi. So, what is Coke doing different and how are people getting affected by the brand name. Coke has created a brand loyalty by using gestures such as happiness, friendship, relaxation, love and family. It triggers the emotional quotient of people rather than just selling a carbonated drink.

Taking an example of Google, Google has tried '50 shades of blue' for creating its search results menu. By choosing a color which is more soothing for users, Google has gained 200 million dollars of extra revenue. The color would let the users click more on the advertised links, generating ad revenue for Google.

Amazon has used Social Proofing technique by suggesting Star rating, Amazon's Choice, #1 Best Seller and over 4000 non-consumer feedback's. These reviews create a natural bias for the product in the mind of the non-consumers. People tend to assume that, if more people are buying, it is certainly of good value. A subtle but an appropriate use of this technique is bringing more non-consumers for Amazon.

In the theaters, audience look at the big screens without many distractions and then they see the famous Smoking Kills – "Mukesh Ad". The basic purpose of this ad is to help smokers quit smoking. Since the ad is very negative in terms of emotions and visuals, audience turn their faces from the advertisement. The whole purpose of the advertisement to connect with those who actually smoke cigarettes is thus lost.

An eye tracking experiment was conducted at a retail store where a poster was used to gain audience attention. The poster had a text and a baby image gazing at the audience. The results showed that poster could only gain attention of the baby and not the text, thus failing to deliver the message. Later, the poster was altered with the baby gazing at the text and not the audience which helped the advertiser convey its message.

Understanding the human brain and designing every bit of marketing is helping companies perform better by spending less. It is a method which is giving clear results when compared to the traditional approaches. Thus, companies are now diverting their market research strategies more towards the cognitive thinking for learning the consumer behaviors. A shift from random marketing to strategic brain-based marketing is the change brought by Neuromarketing.

2.2 THE NEUROSCIENCE OF PERSUASION

Studies of persuasion have typically targeted attitudes and behavior. Behaviors refer to observable actions by a person, whereas attitudes refer to general and enduring evaluative (good/bad, harmful/beneficial, wise/foolish) predispositions toward a stimulus or category of stimuli. Attitudes have been emphasized in research on persuasion for decades because attitudes serve important social and psychological functions and can influence decisions and behaviors. For instance, attitudes serve as convenient summaries for one's beliefs, emotions, and preferences regarding issues, objects, and people; they facilitate the differentiation of hostile from hospitable stimuli; they help us to know what to expect when exposed to a stimulus; they reduce the stress of decision making; they help others to know what to expect from us and we from them; they help us accomplish our goals; and they serve to express important aspects of our individual personalities.

One feature that makes attitudes so functional is their capacity to change in light of new information, goals, and challenges, and this feature makes persuasive appeals important and ubiquitous in contemporary society. Moreover, people not only form and use attitudes spontaneously to help guide their behavior through a complex world, they also engage in persuasion in an attempt to change the attitudes and influence the predispositions, decisions, and behaviors of others. Sometimes people even engage in deliberate self- persuasion when they wish to hold attitudes others than the ones they currently have.

Attitude Measurement. Scientific research on attitudes and persuasion dates back to the 1920's with work on attitude measurement. Self-reports of attitudes, behavioral intentions, behaviors, and perceived persuasiveness are among the outcomes to be found in contemporary persuasion research in the social sciences. These constructs are distinct, play different roles in persuasion, and have measures with known strengths and weaknesses. An early review by researcher emphasized that self-report measures were valid to the extent that respondents were willing and able to provide accurate reports. The inaccuracies in predicting voting by the pre-election political polls in 2016 can be explained in part by the unwillingness of the supporters for Trump to express an unpopular position. This review renewed concerns about self-report measures of socially inappropriate or unpopular positions or behavior, and both behavioral and neuroimaging studies have provided evidence that social desirability concerns can compromise the validity of self-reported states including attitude ratings.

Importantly, it was not until Nisbett and Wilson's (1977) influential critique of self-report measures of cognitive processes that the limits of what respondents were able to report accurately were clarified. Nisbett and Wilson (1977) proposed that "when people attempt to report on their cognitive processes, that is, on the processes mediating the effects of a stimulus on a response, they do not do so on the basis of any true introspection". They presented evidence that such self-reports were invalid because: (a) people can be unaware of the existence of a stimulus that influences a response, (b) they can be unaware of the existence of the response, and (c) they can be unaware that the stimulus has affected the response. This critique is sometimes misapplied to self-report measures of momentary states such as attitudes, behavioral intentions, thoughts, mental images, recollections, emotional states, or reports of behavior – measures that do not ask participants to report on their cognitive processes (e.g., to rate the putative effects of an ad on their mental state) but only to report mental content of which they are aware.

In contrast, when participants are asked to rate a question such as how persuasive is an ad or appeal, they are being asked to report on the product of their cognitive processes – how much would a stimulus change their attitude or behavior, or how much would a stimulus change the attitudes or behaviors of other recipients. Nisbett and Wilson (1977) argued that such reports were fundamentally invalid even though they may provide accurate prediction in some cases – not because these reports represent valid measures in some circumstances but because the self- reports are aligned with a folk theory whose prediction happens to coincide with the observed outcome. The most common measures found in the behavioral literature on persuasion, therefore, are rating scales regarding states of which respondents are willing and able to report accurately (e.g., attitudes, behavioral intentions, behaviors, that do not raise social desirability concerns) rather than the processes mediating the effects of a stimulus on a response (e.g., perceived persuasiveness of an appeal). Put simply, although people can report what their attitudes are, they may be quite inaccurate in reporting whether their attitudes have changed from a previous point in time or what process led to the attitude they now hold.

Persuasion

World War II and the German propaganda machine shifted scientific attention from attitude measurement to persuasion and propaganda and led to the Message-Learning Approach following the war. Hovland and colleagues never proposed a formal theory of persuasion, but rather they were guided by "working assumptions" that were loosely translated from principles of how people learn verbal and motor skills. Briefly, the message learning approach emphasized the serial operations of attention, comprehension, yielding, and retention, and research was organized to investigate the influence of who (source factors) said what (message factors) to whom (recipient or audience factors) how (channel factors) on persuasion.

There was a large literature on the effects of source, message, recipient, and channel factors by the early 1970's, and concerns were expressed about the replicability of findings because the same experimental factors (e.g., source expertise) were associated with different outcomes in different studies or when using different methodologies or paradigms. Social behavior ranging from attitudes and persuasion to violence and zealotry are rarely the result of a single genetic, situational, or cultural cause, however. If the empirical inconsistencies in causal effects represent a generalizability problem rather than a replicability problem, then the divergent findings in the behavioral literature represent a puzzle regarding what might be the theoretical conditions expected to produce each causal effect and what might be the moderator variable(s) that specifies when each theoretical condition exists. Tackling this theoretical puzzle led to the development of the Elaboration Likelihood Model, which specified the multiple processes (sets of cognitive & affective operations) through which attitude change could occur, and identified the theoretical conditions in which a given factor or set of factors would trigger each process. The theory helped organize what had appeared to be conflicting results and generated predictions of new patterns of data that were subsequently verified.

According to the ELM, individuals can reach the same attitude position via different sets of cognitive and affective processes, each of which involves both automatic and controlled components. Although people are motivated to hold veridical attitudes, the set of processes through which an attitude is formed or changed depends on the likelihood that the recipients are motivated and able to devote the cognitive resources necessary to idiosyncratically evaluate the personal relevance and merits of the information (e.g., message arguments) for or against an attitude position. Attitude change can result from the cognitive elaboration of issue-relevant information when the motivation and ability to engage in this careful evaluation is high (central route), or from an associated peripheral cue that serves as a simple heuristic or affective input regarding the veracity or desirability of an attitudinal position when the motivation and/or ability to think is low (peripheral route).

Importantly, the central and peripheral "routes" refer to families of high and low effort processes of which there was more than one instantiation. For instance, although the central route involves more idiosyncratic issue-relevant thinking than the peripheral route, this thinking can range from being relatively objective to being deeply biased. According to the ELM, the route through which an attitude is changed has implications for how consequential that attitude will be, such as how strong and resistant to change it will be and how likely it will influence decisions and behaviors. For instance, the link between attitudes and behavior is fortified when an attitude is strong and accessible, bears specifically on the behavior that is being predicted, and is connected to a personal goal. Because the same attitude or behavior change can derive from different sets of processes, it is important to understand not only the attitudinal or behavioral effects, but also the underlying set of information processing operations responsible for these effects – especially whether the induced change stemmed from relatively high or low degrees of thinking.

A similar theory, the heuristic-systematic model, distinguished between source factors, which were posited to induce low effort heuristic information processing that could produce persuasion, and message factors, which were posited to induce higher effort systematic information processing to produce persuasion. In addition, the unimodal posited that there are not multiple sets of processes underlying persuasion, but rather that there is a single mechanism that reflects the extent to which a given factor (e.g., number of message arguments) serves as evidence for the advocated position, and that the set of psychological operations acting on this factor is not altered by the recipient's motivation and ability to think. Contrary to the unimodal, however, there is evidence from behavioral studies that the same factor in a persuasive appeal, such as the number of message arguments or source expertise, can lead to attitude, intention, or behavior change through a different set of information processing operations depending on the person's overall level of motivation and ability to think.

For instance, in a between-subjects factorial design, Researcher demonstrated that the same message factor (number of arguments in a persuasive message) could affect persuasion through different processes depending on the circumstances.

Participants were randomly assigned to receive a persuasive appeal that varied in Argument Quantity (three or nine arguments), Argument Quality (either all cogent/strong arguments or all specious/weak arguments), and Personal Involvement (the appeal was of high or low relevance). Results indicated when personal involvement was low and motivation to think was therefore minimal, the manipulation of Argument Quantity influenced attitudes by serving via a simple numerosity heuristic (i.e., more is better) such that 9 arguments led to more persuasion than 3 regardless of quality. In contrast, when personal involvement and therefore motivation to think was high, Argument Quantity had an impact because people processed the arguments carefully and thus having more arguments increased persuasion when the arguments were cogent but decreased persuasion when the arguments were specious.

Behavioral theories and research on persuasion raise several important issues for the evaluation of the existing research on and the design of future studies of the neural bases of persuasion. In the next section, we discuss four general implications of this behavioral research when considering fMRI studies of persuasion.

Implications for fMRI Studies of Persuasion

Decades of research have been devoted to the development and deployment of behavioral measures (e.g., rating scales) in contexts in which they are valid and reliable. The selection and use of behavioral measures in fMRI studies of persuasion should be in accord with the results of this behavioral research. For instance, the reliability and validity of measures of attitudes, behavioral intentions, or behaviors are generally good as long as the rated position is not embarrassing or socially unpopular. The validity of self-report measures of the effects of a stimulus, such as the “perceived persuasiveness” of an argument or message, has been questioned. Studies of the neural correlates of people’s self- reports of perceived persuasive may be worthwhile, but as noted earlier perceived persuasiveness and actual persuasiveness should not be conflated.

Second, the behavioral literature on attitudes and persuasion provides evidence against the early notion that source, message, channel, and recipient factors produce simple main effects that generalize across situations and contexts. A better integration of behavioral theories, paradigms, and measures for investigating mediating information processing operations and moderating variables into fMRI studies of persuasion would be helpful in the interpretation of the neuroimaging data, and strong inferences based on neuroimaging data would help refine and advance theories of persuasion.

Third and relatedly, there is considerable evidence in the behavioral literature that the same outcome (e.g., post-message attitude, behavioral intention, behavioral proxy, or objective behavior) can be achieved through different sets of information processing operations. For example, in the argument quantity versus quality study described above, 9 strong arguments led to more persuasion than 3 strong ones under low involvement conditions because people simply counted the arguments but under high involvement conditions the same positive outcome was achieved because people thought about the arguments carefully and appreciated their merit. Therefore, the same outcome measure across conditions or across studies may be associated with the activation of partially (or completely) different patterns of regional brain activation because partially (or completely) different sets of information processing operations were evoked by the persuasive appeal even when a behavioral outcome across conditions appears to be the same. If the set of information processing operations triggered by a persuasive appeal differ, then the neural processes underlying these cognitive operations should also differ.

Fourth, not only are the effects of persuasive appeals multiply determined, so too are changes in the activation of many if not most cortical regions. This means that an inference regarding the engagement of a particular information processing operation from the activation of a specific brain region is not deductively valid. This inferential problem in studies of the psychological processes associated with regional changes in brain activation in fMRI studies is known in the neuroimaging literature as “reverse inference” and is know more generally as the logical error of affirming the consequent or converse error. This logical error and the problems it creates for drawing strong inferences from empirical data (e.g., physiological signals) were specified in mathematical (Bayesian) terms by researcher and extended to the interpretation of fMRI data soon thereafter. We return to these issues following our review of neuroimaging studies of persuasion.

Neural Correlates of Message-Induced Persuasion

Most of the research and theory on persuasion have focused on influence attempts in which an individual or group exposes a recipient or audience to an appeal with the intention of changing attitudes or behaviors, either by moving the attitudes or behaviors closer to an advocated position or by strengthening attitudes or behaviors that are already aligned with the advocated position. In this section, we focus on studies of the regional brain activation in response to a persuasive appeal that influenced attitudes or behavioral intentions. For details of individual study methods and results, see Table 1.

Source Factors. In an early study, author investigated the neural correlates of source expertise using a procedure that was designed to mimic advertisements pairing a celebrity and a product. Participants were exposed to a picture of a celebrity followed by a picture of a product. In half of these presentations the object fell within the expertise of the celebrity (i.e., high expertise condition; e.g., Andre Agassi followed by a pair of tennis shoes), and in half of the presentations the object fell outside the expertise of the celebrity (i.e., low expertise condition; e.g., Andre Agassi followed by an alcoholic beverage). Following each celebrity/object pair, participants indicated whether or not they perceived a link between the celebrity and the object. The day after the scanning session, the participants' behavioral intention toward each object, recognition memory of pairings, and familiarity and attractiveness of the celebrities were measured.

A contrast in the fMRI analyses compared the responses to objects that were preceded by celebrities rated as high in expertise minus objects that were preceded by celebrities rated as low in expertise. A whole brain analysis indicated that the effect of expertise on purchase intentions was mirrored by differences in activation in an array of regions in the prefrontal cortex as well as the precuneus, anterior cingulate cortex (ACC), superior temporal gyrus (STG), and medial dorsal thalamus. In addition, a whole brain analysis of the "interaction" between celebrity expertise and subsequent attitude effect indicated that celebrities subsequently rated as high in expertise evoked particularly larger increases in activity in the right and left caudate nuclei and right and left superior frontal gyrus (SFG) within the MPFC to objects that participants subsequently evaluated positively. The results for the caudate nucleus were interpreted in terms of an expert increasing a recipient's trust in the quality of the product. Among the concerns raised by the study are that neither of the "factors" in this interaction test was experimentally manipulated, and the interpretation that activation of the caudate nucleus as reflecting trust reflects a reverse inference. However, the study represents a pioneering effort to investigate the neural correlates of persuasion using ecologically valid stimulus materials, and the results provided early evidence that there was not a single brain region activated by persuasive appeals but rather that activation changed across regions within and beyond the prefrontal cortex. This, then, set the stage for asking questions about what specific regions within the prefrontal cortex are involved, what other regions in the brain are involved, under what conditions each region is involved, and to what specific persuasion process each neural region or network of regions is related.

Neural Correlates of Behaviour Change Following Exposure to a Persuasive Appeal

Reported Health Behavior. Researcher exposed participants in southern California to slides containing text and images from expert sources regarding sunscreen use. Prior to scanning, participants indicated their use of sunscreen during the prior week, their intentions to use sunscreen in the coming week, and their attitudes toward sunscreen. During scanning, participants were instructed to read along silently and to consider each slide carefully, and they were informed they would be asked questions about the slides following the scanning. Following scanning, participants again indicated their attitudes toward sunscreen and their intentions to use sunscreen in the next week, and were given a bag that included sunscreen towelettes. One week following the scanning, participants were contacted by email and asked to report the number of days that sunscreen had been used. Regions of Interest (ROIs) were constructed within the anterior MPFC and the precuneus based on the results of researcher, who interpreted the results in terms of self-relevant message processing, and who interpreted their results in terms of the encoding of “intention” prior to conscious decision making.

Activity in the MPFC ROI during presentation of the persuasive appeals, compared to rest, predicted the reported change in sunscreen use. This result remained significant after controlling for changes in attitude and intention. Activity within the precuneus was positively but not significantly related to behavior change. Falk, Berkman et al. (2010) interpreted these results as indicating that the change in regional brain activity within a portion of the rostral MPFC predicts behavior change above and beyond self-report measures of attitude or intention change. If the southern California participants already possessed generally positive attitudes and intentions toward the use of sunscreen, it is conceivable that the persuasive messages served to increase idiosyncratic issue-relevant thinking – as researcher suggested – which behavioral research suggests would strengthen attitudes and intentions (e.g., enhance accessibility or certainty) and increase attitude-congruent behavior, thereby potentially explaining the association between activity in the MPFC ROI and sunscreen use the week following the scan.

Exploratory analyses of whole brain activity by Falk, researcher suggested additional regions that were related to behavior change, including activity within the posterior superior temporal sulcus (pSTS), TPJ, temporal pole, hippocampus, supplementary motor cortex, inferior parietal cortex, occipital cortex, motor cortex, and insula. These results were interpreted as consistent with theories of social learning that posit "behavior change can result from encoding information about social norms, incorporating those norms into one's own self- concept, and planning to execute the relevant behaviors" No independent evidence was provided that participants encoded information about social norms, incorporated those norms into their own self-concept, or planned to execute the relevant behaviors during the persuasive appeal, nor are these the only psychological processes that are associated with activity in these brain regions. Nevertheless, researcher seminal investigation stimulated a series of studies on predicting behavior following a persuasive communication by regional changes in brain activity in response to the persuasive communication.

Researcher investigated the prediction of smoking cessation by the neural responses to persuasive messages in smokers who were interested in quitting within the next 30 days.

Prior to scanning, participants completed surveys relevant to smoking cessation. During the scanning, participants were exposed visually and aurally to high-tailored persuasive messages designed to promote smoking cessation, generic smoking cessation messages, and neutral messages that were unrelated to smoking cessation. The messages were similar to those used by researcher and described earlier. Participants also completed a self-relevant adjective task (adjective does or does not describe you versus adjective is positive or negative) to identify regions involved in self-relevant processing. Following the scanning session, participants were given a 10-week supply of nicotine patches, completed a web-based tailored smoking-cessation program, and were instructed to quit smoking. Four months later, participants were called and responded to a 7-day point prevalence abstinence measure (cigarette free for the past 7 days).

Participants were categorized as quitters and nonquitters.

Conjunction analyses of the self-relevant adjective task and persuasion task identified three common regions: the DMPFC, precuneus, and angular gyrus. The mean beta estimate across the voxels within each of these regions during exposure to the tailored persuasive messages, relative to the neutral messages, was then used to predict smoking cessation (i.e., quitters versus nonquitters). Results indicated that activity in the DMPFC predicted smoking cessation, activity within the precuneus was marginally related to smoking cessation, and activity within the angular gyrus did not approach statistical significance. Additional analyses provided by researcher in online supplementary materials are also summarized in Table 2. Among the strengths of this study are that the manipulation of message tailoring (personal relevance) corresponds to manipulations in the behavioral literature that have been shown to lead to differences in idiosyncratic issue-relevant thinking and the conjunction analysis that provided independent evidence that self-relevant processing may have been evoked by the high, in contrast to low, tailored messages. Together, these design features and results provided additional evidence consistent with the possibility that the processes underlying the prediction of behavior change by activity within the MPFC have something to do with the self (e.g., enhanced elaborative thinking).

Objective Measures of Health Behavior. In a follow-up investigation, for instance, researcher refined their ROI within the anterior MPFC based on the whole brain analyses by researchers to examine the extent to which neural responses to ads designed to help people quit smoking predicted behavior change. Participants who were heavy smokers were recruited from a smoking cessation program, and prior to scanning, participants completed a variety of measures including self-reported smoking behavior, intentions to quit smoking, and exhaled carbon monoxide. During scanning, participants were exposed to professionally developed TV commercials designed to help smokers quit smoking. Ads were chosen based on discussions with experts to be most personally involving or relevant to smokers who were trying to quit smoking. Following each ad, the participants rated the extent to which the ad made them feel a sense of self-efficacy about quitting smoking ("This ad makes me feel I can quit"), increased intention to quit ("This ad makes me more determined to quit"), and its self-relevance ("I can relate to this ad"). Approximately one month later, expired carbon monoxide and self-reported smoking were measured.

Changes in expired carbon monoxide served as the criterion measure, and activation in the ROI within the MPFC during exposure to the ads, self-relevance ratings, and the mean of the measures of intention to quit and self-efficacy served as predictors in regression analyses.

Results indicated that: (a) self-reported intentions, self-efficacy, and ability to relate to the messages predicted behavior change; and (b) activity in the MPFC ROI predicted behavior change even when statistically controlling for self-reported intentions, self-efficacy, and ability to relate to the messages. Finally, exploratory whole brain searches regressing neural activity onto changes in expired carbon monoxide, detailed in online supplementary materials, indicated that behavior change was also associated with regions of activity in the posterior cingulate, precuneus, and supplementary motor area.

Replications and Component Processes. Subsequent replications have also provided evidence for the replicability of the association between activity within the MPFC in response to a persuasive communication and changes in behavior following the communication.

Importantly, recent studies are also beginning to identify boundary conditions for this association. For instance, Researcher found that the prediction of click through rates by activity in the MPFC ROI depended on the nature of the image.

Specifically, activity in the MPFC ROI predicted click-through rates for ads with graphic negative photos but not for ads with neutral photos. In addition, researcher found that activity in the MPFC ROI predicted changes in sunscreen use when the persuasive message focused on “why” one should use sunscreen but not when the message focused on “how” one should use sunscreen.

The rationale for identifying the MPFC ROI, the means used to identify the MPFC ROI, the specific subregions of the MPFC that have been identified (e.g., dorsal or ventral subregions), and how the activation of the MPFC ROI was related to behavior have varied across these studies, but the cumulative work suggests that regional activity within the MPFC in response to persuasive messages is correlated with behavior change in most of these studies. Among the commendable features of this research are the replicability of the association between activity in the MPFC and behavior change and the increased use of tasks or measures that provide independent evidence that a particular cognitive or affective (e.g., self-related) process may be involved.

Questions remain regarding the specific nature and extent of any such self-related processes, and the extent to which any such differences correspond to the observed differences in neural activation that predicted behavior. For instance, researcher suggested that “MPFC activity in this context reflects an implicit connection between the self and the behavior in question (in this case quitting)”, or an unspecified process that differs from intention, self-efficacy, or ability to relate to a message such as envisioning oneself performing the behavior in question or the planning of specific actions needed to achieve the behavioral goal of smoking cessation. Researcher interpreted parts of the regional MPFC activation in terms of researcher’s hypothesis that the extent of self-related processing such as elevated issue-relevant thinking in response to a persuasive message. Researcher interpreted their results to mean that the activity in the MPFC may have reflected a greater engagement of self-related processing, allowing for “deeper processing and more efficient integration of the newly formulated health-change goals into one’s learning, self- schema, and action plans”. Researcher suggested that thinking about one’s core values may be involved, and researcher raised the possibility that “seeing value and incorporating persuasive messages into one’s self-concept” may be involved.

Of course, the MPFC is involved in various kinds of self-referential thinking as well as other kinds of information processes. For instance, researcher recently applied a meta- analytic data-driven approach to nearly 10,000 fMRI studies to distinguish among presumably separable regions of the medial frontal cortex and to determine which psychological processes preferentially recruit their activation. All of the MPFC ROIs designated across the studies of persuasion and behavior change appear to fall within researcher termed the anterior zone, whose functional profile was described as “strong associations with affect, decision-making, social cognition, and episodic memory, accompanied by activation with the default network”.

Importantly, researcher further noted that the anterior zone of the medial frontal cortex was fractionated into three functionally dissociable subregions. The first was a dorsal cluster (DMPFC), which included medial aspects of frontal pole and SFG and was entirely outside of the ACC. The meta-analysis indicated that the DMPFC subregion of the anterior zone of the medial frontal cortex was strongly associated with social cognition such as social perception and self-referential thinking. The second subregion was a more ventral cluster (pregenual anterior cingulate cortex, which was primarily located within pregenual aspects of the anterior cingulate gyrus but included pregenual portions of paracingulate gyrus. The meta-analysis indicated that the pgACC subregion was functionally less specifically organized, showing moderate associations with both decision-making and affective processes. Finally, the third subregion of the anterior zone was a ventral cluster (VMPFC), which included both pregenual aspects of the ACC and medial OFC. The meta-analysis indicated that the VMPFC was primarily associated with affective processes such as reward (including valuation processes) and researcher suggested that the VMPFC may play a role as an integrative relay station for subcortical affective input to the cortex, whereas more dorsal regions contextualize this affective input.

The meta-analysis of researcher provides a functional differentiation of regions of the medial frontal cortex and highlights the multiply-determined nature of activity within as well as across subregions of the medial frontal cortex. The meta-analysis also raises questions about just how much discriminating information neural correlates can provide about the specific nature of social, self-relevant, and affective message processing elicited by persuasive appeals.

What might the studies of the prediction of behavior by activity in the MPFC tell us about persuasion in light of this meta-analysis? The coordinates of the MPFC ROIs were not specified or illustrated in all studies. However, the information that was provided from atlas coordinates or illustrations can be used to possibly identify the subregion of the anterior zone in which the ROI in the studies reviewed in this section was primarily located. Drawing on this information, the MPFC ROIs for the studies reviewed in this section appear to have fallen primarily within one of two subregions: the DMPFC subregion. Given researcher meta-analytic finding that these subregions are functionally separable and are activated by different kinds of psychological processes, it is reasonable to posit that the nature of the processes triggered by the persuasive appeals in these two sets of studies are functionally distinguishable, with the first set showing a pattern of MPFC activation that de la Vega et al. found to be strongly characteristic of social cognition, and the second set showing a pattern of MPFC activation that was found to be primarily characteristic of affective processes including valuation, reward, and fear processes.

Behavioral research has long suggested these types of processes could be involved in persuasion.

However, it is important to note that there are also large and important variations in the information processes that fall within each of these broad functional categories, and additional research is needed to test among various hypotheses. The complementary nature of behavioral and neuroimaging research makes it possible to provide such tests. For instance, studies of the neural correlates of persuasion may be advanced by taking greater advantage of the theories and methods/paradigms that have been developed over the past half century of behavioral research on persuasion to discriminate among these putative mediating information processing operations.

For instance, there are several hypotheses that might account for the results showing that activation in the DMPFC subregion during a persuasive communication predicts behavior. These hypotheses, which include some posited in the extant literature, fall within the functional category of social cognition identified by researcher as associated with activation of the DMPFC subregion of the medial frontal cortex: (a) the formation of an implicit link between the self and the advocated behavior change; (b) the formation of a more detailed action plan linking the self and the advocated goal; (c) the formation of an implicit link between some simple peripheral cue and the advocated behavior change (e.g., source expertise, number of arguments, the negative images have me aroused, so it must be true); and (d) the extent and nature of the idiosyncratic issue-relevant thinking that is evoked, with the consequent behavioral prediction dependent on the idiosyncratic issue-relevant thinking reflects primarily pro argumentation regarding the advocated position (e.g., I don't want to end up like others who have smoked heavily, so I need to cut back). The limiting conditions identified by researchers seem to be most consistent with the last two hypotheses. For instance, if activation of the MPFC reflected the formation of more detailed action plan linking the self and the advocated behavior change, then activity in the MPFC might have been expected to predict behavior change in the "how" condition in researcher in addition to (or instead of) in the "why" condition. Although suggestive, direct tests of these and other theoretical possibilities are needed.

Neural Correlates of Perceived Persuasiveness

Finally, a few articles have appeared in which self-report measures of perceived persuasiveness was used as a proxy for message-induced attitude or behavior change. As noted above, however, researchers work calls into question the validity of reports regarding the extent to which an argument or message is persuasive or would change their attitudes or behavior. Consistent with concerns about equating "perceived persuasiveness" with actual persuasiveness, researcher found that a message containing colorful language was rated as more persuasive but produce no significant attitude change. They suggested that the widespread belief that colorful language facilitates attitude change influenced the ratings of the persuasiveness of a message even when, in actuality, they were not persuaded by the message. Researcher measured both perceived and actual persuasiveness in a study of participants who read a newspaper article advocating for the construction of a cultural center. Results revealed that these measures were not equivalent, and that the correspondence between perceived and actual persuasiveness was poorer for causal than anecdotal or statistical evidence. Researcher found people were poor at predicting changes in their attitude toward (e.g., their liking for) ice cream, yogurt, and a short musical piece over the course of a week. Finally, researcher used perceived persuasiveness ratings in their pilot tests when developing persuasive messages for their neuroimaging study. When an unexpected trend emerged in these ratings, the authors noted that: “we believe this trend was likely due to [the pilot Ps] inability to correctly predict which messages may be most effective in promoting desired behaviors, a consistent finding in the literature”. Studies of perceived persuasiveness may be interesting in their own right.

2.3 NEURO MAP: A BRAIN-BASED PERSUASION THEORY

The critical component for persuasion is engagement—the ability to attract and keep attention—no matter what the technology. All physical and psychological experience, including our ability to notice and attend, is first filtered and then constructed by subconscious sensory processing systems, therefore persuasion, as the outcome of attention, starts in the brain.

1. The triune model of the brain

In the 1960s, the neuroscientist and physician Paul MacLean proposed the triune, or three brain hypothesis that has been increasingly adopted by the fields of marketing (‘neuromarketing’), design, and leadership. While simplistic relative to the physical complexity of the human brain, this model highlights instinct-, emotion- and identity-driven motivations and provides an accurate and useful framework for understanding and triggering human response to different stimuli and experiences. Researcher suggest that the three-brain model is a powerful approach for understanding the persuasiveness of AR, because AR applications integrate virtual information with direct multi- sensory experience and create multiple conscious and unconscious entry points of engagement and influence.

Unconscious and conscious thought: instincts, emotions and identity

The human brain evolved new capabilities over the millennia by layering functional areas on to its physical mass. The result is a composite of evolutionary progress. MacLean's three-brain model links the differences in the behaviors from each major functional area to the evolution of animal life, arguing that the brain effectively has three parts that are representative of their stage of evolution: the reptilian or old brain, the emotional center or mammalian brain, and the neocortex or the new brain, as illustrated in Figure 2.1.

The most primitive sections of the brain, the reptilian brain and the mammalian brain, operate subconsciously. The reptilian brain, comprised of the brain stem, mid brain and basal ganglia, is the oldest and most primitive. It controls instinctive physical behaviors, such as breathing, as well as survival-related responses such as aggression and fear. Although primitive, the reptilian brain is highly sensitive to proximity, self-relevance, reward, and threat. It continually monitors the environment for potential danger by assessing change, and identifying patterns and familiarity.

The emotions were the next functions to develop in the brain. The mammalian brain is the emotional center located in the limbic system, which includes the amygdala, hippocampus, hypothalamus and other structures. It mediates social emotions such as attachment, liking, love, pride, guilt, shame, and scorn as well as behaviors related to maternal nurturing and play. Where the reptilian brain responds to primitive, physical-survival instincts, the mammalian brain supports the survival of the organism through socially-based emotional response and the drive for social connection. Together, the reptilian and mammalian brains are responsible for instinctive responses that activate multiple physical and emotional systems for quick reactions, such as fight or flight or protecting offspring.

The third part of the three-brain model is the neocortex. From an evolutionary perspective, the neocortex is the newest part of the brain and is what distinguishes humans from other mammals. It is the center for conscious thought, such as conceptual, higher order learning, language, problem-solving, sequential thought such as planning, and the ability to have conscious awareness of a 'self' and identity that are central to concepts such as self-esteem, self- efficacy, and agency.

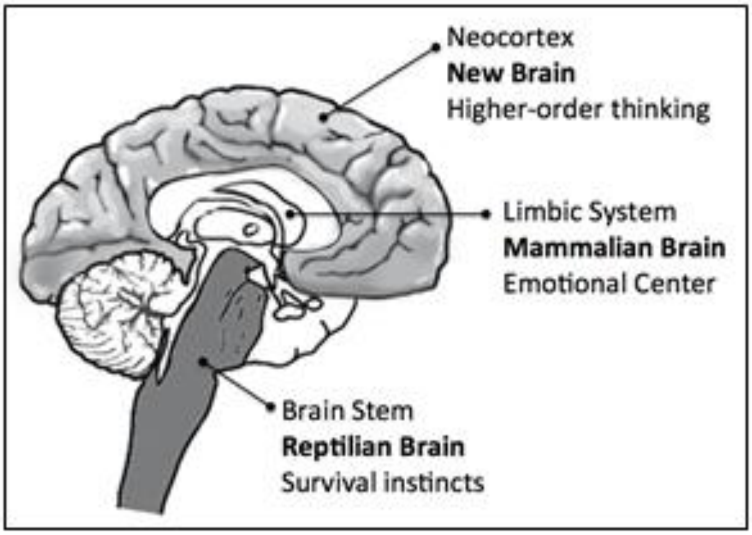


Figure 2.1: Triune Brain Model

These distinctions in functionality represent the dichotomy between primitive brains' unconscious holistic cognition derived from sensations, bodily symptoms, drive and emotions, and the 'new' brain's conscious analytical, linear processing of information. The unconscious brain speaks the language of image and feelings and can experience only the present. By contrast, the neocortex consciously processes information as what Bertrand Russell famously described as 'knowledge by description' versus 'knowledge by acquaintance,' or knowledge that results from judgment and interpretation rather than from direct sensory awareness. This is a relevant distinction for AR as technology becomes more experiential.

Theoretical links: Brains as information processors

The triune brain theory can be mapped to several psychological theories of information processing and persuasion. The unconscious versus conscious processing of information in the triune theory is analogous to William James' theory of awareness as a composite of the focused attention, or nucleus, and the unattended awareness, or fringe. The preconscious processing of the reptilian brain can also be equated with Researcher implicit knowledge — things we know that are not in awareness — and with Ulric Neisser's investigation of attended and pretended content. It can also be seen as the difference between direct perception and information 'pickup' as applied to visual perception by Researcher.

Comparably, dual pathways theorist Chaiken's Heuristic-Systematic model posits that people process information in both systemic and heuristic ways where systemic processing is attended and intentional and heuristic processing involves patterns and cues that unconsciously influence a decision. The Elaboration Likelihood Model (ELM) similarly proposes multiple routes for message processing. In the ELM model, commonly applied in marketing research, messages received in the central route receive careful scrutiny and evaluation, where messages received in the peripheral route are not consciously processed but may exercise significant influence in unpredictable ways.

2. The benefit of the brain perspective

The triune brain model, unlike dual pathways persuasion models, places the emphasis on the relative influence of the conscious/direct versus unconscious/peripheral pathways to persuasive processes. The triune model stresses the dominance of the reptilian brain in information filtering and subsequent research has supported this contention, demonstrating that initial preconscious processing is responsible for as much as 95% of decision-making. Thanks to the philosopher Descartes, we are culturally predisposed to think of the brain and body as separate. There is ample evidence, however, that thoughts, emotions and the body are mutually influential. Advances in neuroscience and brain scan technologies, however, support the application of the triune brain model to understand how motivation, trust, and attitude change can activate the brain. Researchers have applied fMRI (functional Magnetic Resonance Imaging) and measured the level of the reward system neurotransmitters, such as oxytocin, to track the way the brain receives and responds to different messages and images. They have been able to track positive emotional responses to stimuli such as puppies, babies and even Twitter retweets. The unconscious brain response translates into many daily experiences. Studies show, for example, that stress interferes with sleep and digestion, petting a dog lowers blood pressure, and when someone smiles at another person, mirror neurons trigger a smile response that is accompanied by a chemical pay-off through dopaminergic reward systems in both people.

Psychologist Jonathan Haidt provides a useful visual metaphor of an elephant and a rider to illustrate the imbalance of power between the brain's instinctive responses as the giant elephant and the conscious brain's abilities as the small rider to control attitudes and behavior. While the separate systems of the brain are inextricably linked through the continuous communication of neurotransmitters, the strength of instinctual processing at the unconscious level dictates most decisions and actions.

No matter their origin, persuasive effects operate at multiple levels simultaneously, from motivating initial product engagement and ease of use (e.g., can an individual easily and effectively use a device?) to specific targeted behavior or attitude change (e.g., will this help the individual achieve a goal, such as an eating healthier?). Fogg makes the distinction between macro level persuasion that has a distinct persuasion-based outcome goal, such as smoking cessation, compared to the micro level persuasion that is inherent in usability design that increases productivity and enhances the subjective experience, such as self-efficacy, of the user. At any level, the goal or desired outcome of an application is for an individual to process a persuasive communication so that it becomes internalized into his/her core belief system to achieve an attitude or behavioral change at some level. In other words, the AR experience must be immersive and seamless. For this to happen, the AR application must arouse the primitive instincts in the reptilian brain. Based on the three-brain model, this can only happen if it the application is clearly relevant to the user, solves a problem, offers a reward or poses a threat.

- **Applying brain-based guidelines**

The triune brain model suggests three main areas of focus for targeting design and analysis, one for each level of the brain: instinctual responses, emotional responses, and identity responses. They can function independently, but, given the inter- relatedness of the brain, are more often simultaneous and mutually reinforcing.

As described above, the primitive reptilian brain is only focused on information that directly impacts survival: immediate relevance followed by reward or threat.

a. Relevance and reward

Recognition and immediacy determine whether information in the environment will trigger the attention of the primitive brain. Human brains are wired to notice indicators of danger; this includes change and contrast, things that are new or unusual, emotionally as well as perceptually. As the reptilian brain scans the environment for patterns and movement, the appearance of an AR simulation with rich media produces novelty and change, enhance attention and physical arousal, and make delivered information more salient, memorable, and actionable.

Once information is attended, cognitive processing continues by comparing new information to previous experience to determine the level of reward or threat. The more familiar the information, the less likely it is to trigger a threat response, and the more likely the brain is to interpret the stimuli as positive or being of value. Content is perceived as self-referent and suggests similarity in addition to relevance delivers increased perception of value. Historically, our likelihood of survival was increased by affiliating with those things most familiar to us, from people to environments. The ability to self- reference and self-identify leads to a favorable evaluation of a product or experience no matter what the quality of content logic or information. Similarity increases relevance and positive perceptions, or 'liking'. AR applications are on demand, enhancing the sense of control (safety) and personal investment (identity). The content is, by definition, self- relevant because it is pulled to the user on demand, not pushed as in traditional advertising. Useful and accurate content provides a solution to a problem or question, creating a sense of safety and enhanced self-efficacy. Additional preferences give the user control over how the information is displayed. The user has choice over exactly where, with whom, and on what device to activate and experience the information. The sensation of success and control by the reptilian brain is processed as reward and triggers positive emotions (pride, happiness) through the dopamine system and is translated by the conscious brain as successful, personal validation and efficacy (identity).

b. Emotion

AR has the ability to tap multiple levels of emotion by linking the affect in present experiences with triggers from virtual experiences. Visual representations are the most effective ways to trigger emotions. Over 50% of the cerebral cortex is devoted to visual processing. The visual system evolved with the haptic nervous system and, therefore, a large proportion of tactile signals trigger the visual cortex. Virtual responses activate the same neural networks as real experiences, recalling all associated sensory and emotional memories, thus virtual overlays will meaningfully enhance emotional and somatic experience.

c. social connection

Social needs are some of the most powerful forces in persuasion. Humans are neurologically- wired to seek social attachment; they are acutely sensitive to social perceptions, inclusion, acceptance and rejection.

The pattern-seeking reptilian brain looks for meaning in the environment and is particularly attuned to the arrangement of shapes suggesting human faces. This socially-oriented biological predisposition also causes humans to attribute personalities and motivations to others, both humans and nonhuman, such as animals and objects. Consequently, people are not only able to see human faces in everything from the moon to potato chips and attribute complex emotions to pets, but the act of anthropomorphizing even inanimate objects, such as computer devices creates a genuine emotional attachment and enhances the persuasive effect.

The human predisposition to attribute human characteristics to objects and devices suggests that AR applications can leverage social rules and dynamics when they successfully reinforce human attributes and interactions, such as the social conventions of praise or support enhanced by the proximity and blended reality of content projected into the user's physical space. The reptilian and mammalian brain responses, biologically driven to seek affiliation, interpret these as genuine social behaviors and social exchange, activating the powerful persuasive effects of the rule of reciprocity, that we must return favors to others, and social validation, that we are valued by others in our group.

The mobility of AR also allows for collaboration among users locally and virtually. Connected to social networks, AR applications can leverage the impact of social proof, that people are influenced by what others around them do, and affiliation or social identity, that we are similar to others we value. Researchers have shown correlations between behavior change and neural activity in regions involved in monitoring social perceptions and have affirmed the role of social factors in the persuasion process. Behavior change is correlated with increased neural activity in areas involved in memory, attention, visual imagery, motor execution and imitation and affective experience. This is consistent with theories of social learning and persuasion suggesting that behavior change can result in social norms into self-concept, underscoring the roles of safety, connection, emotion and identity represented by the three-brain theory.

d. Identity

The new brain categorizes and interprets the information it receives from the unconscious brains in order to commit it to memory for future recall. AR can have powerful impact on conscious cognition through the psychological experiences that enhance identity: self-efficacy, competence and validation. Successful experiences retrieving and manipulating data and being able to act successful and pleasurably result in goal achievements. Sense of reward can be minor, such as ease of use or finding a local coffee shop, to larger milestones such as achieving weight loss. The positive achievements will be reflected both in self-image and in product appreciation and loyalty.

2.4 APPLYING SIX STIMULI TO PERSUADE THE PRIMAL BRAIN

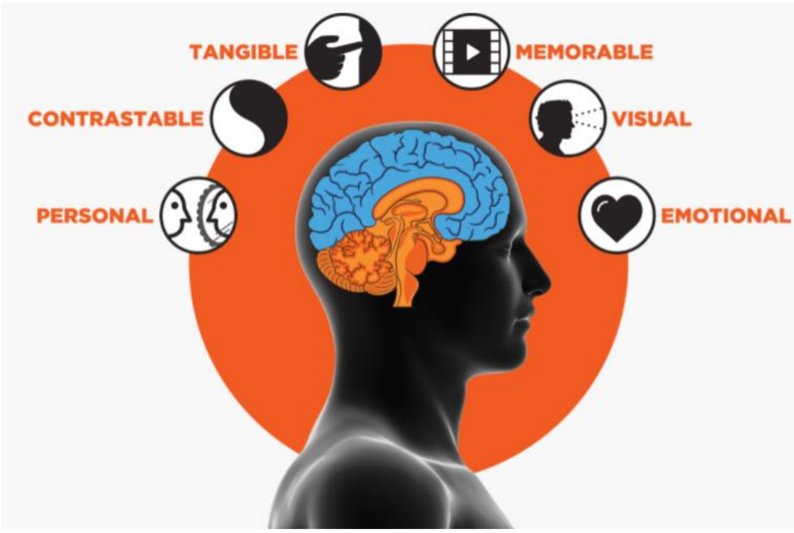


Figure 2.2: Six Stimuli to Persuade the Primal Brain

1. PERSONAL

The 'Primal Brain' is a very self-centered entity and general considerations about others do not reach it. Think of the 'Primal Brain' as the center of ME. Do not assume that it has any patience or empathy for anything that does not immediately concern its survival and well-being.

2. CONTRASTABLE

Before/after, with/without, slow/fast all allow the 'Primal Brain' to decide. Contrast is a safe decision engine. It allows the 'Primal Brain' to make quick and safe decisions. Without contrast, the 'Primal Brain' enters a state of confusion, which ultimately results in delaying a decision.

3. TANGIBLE

Numbers work for the Rational Brain, but the 'Primal Brain' won't decide based on numbers alone! The 'Primal Brain' is constantly scanning for what is familiar and friendly, what can be recognized quickly, what is tangible and immutable. The 'Primal Brain' cannot process concepts like "flexible solution", "integrated approach", or "scalable architecture" without effort and doubt.

4. MEMORABLE

The 'Primal Brain' forgets most of the information it needs to process. This short attention span has huge implications on how to construct and deliver powerful messages. Placing the most important content at the beginning is a must, and repeating it at the end an imperative. Keep in mind that anything you say in the middle of your delivery will be mostly overlooked.

5. VISUAL

The 'Primal Brain' is visual. Neuroscience demonstrates that when you see something that looks like a snake, your 'Primal Brain' warns you instantly of danger so that you react even before the Rational Brain physically recognizes it's a snake. This s because visual processing enters the 'Primal Brain' first which can lead to very fast and effective connection to the true decision-maker.

6. EMOTIONAL

The 'Primal Brain' is strongly triggered by emotions. Neuroscience has clearly demonstrated that 'emotional cocktails' create chemical reactions that directly impact the way we memorize and act.

Chapter 3

CONSUMPTION AS FEELINGS

3.1 FROM THE CONCEPT OF NEED TO THE CONSTRUCT OF PLEASURE AND REWARD

In the first half of the 20th century, to speak about subjective feelings was considered misguided by behaviorist psychologists and reductionist neuroscientists. To behaviorists and reductionists, subjective feeling measures were irrelevant, and feelings were mere epiphenomena. At best, they thought feelings were old-fashioned relics of early intro spectionist psychologists, such as E.B. Titchener, who around 1900 analyzed introspective reports of sensory feelings using trained observers, but found results that were often peculiar to particular observers and in the end amounted to little of general value.

Today subjective feelings again are of wide interest, and for some the pendulum has moved to the opposite extreme. For example, Joseph LeDoux, a distinguished affective neuroscientist, recently argued that emotion is necessarily always and only a subjective feeling, and that verbal reports of feelings are the 'gold standard' of evidence needed to conclude that any emotion exists. For example, LeDoux and Hofmann write "subjective emotional experience, the feeling, is the essence of an emotion," and the only reliable "way to assess conscious emotional feelings is through verbal self-report". For individuals who cannot speak about feelings, including animals, human infants, or brain-damaged aphasic human adults, LeDoux reverts to a stance shared with early behaviorists: such creatures are regarded to have mere reactions, without any emotional feelings at all. He suggests that "Infants can react "emotionally" long before they can feel emotion… Similarly, it is possible, in fact likely, that animals can react "emotionally" "without feeling". To react without feeling is not to have a true emotion at all, according to LeDoux, and he assumes that animal reactions lack any conscious feeling: "I thus assume, until proven otherwise, that a defensive organismic state and its constituent components are implicit (non-conscious)" (parenthetical phrase in original).

This is a striking change in position, because LeDoux is well known for earlier work that aimed to map fear in amygdala-related circuitry of rats. LeDoux considers now that the question of "whether animals react but do not feel, or whether they both react and feel, is, in my opinion, not something we can determine scientifically". To be unable to know something is to be agnostic. But LeDoux goes beyond an agnostic stance regarding animal emotions and instead adopts one of positive denial. LeDoux rejects his own former view of amygdala as a fear system, writing "I and others have called the brain system that detects and responds to threats the fear system (in rats). This was a mistake that has led to much confusion. … I will propose and defend a different way of talking about this research, one that focuses on the actual subject matter and data (threat detection and defense responses)". In short, LeDoux currently grants animals to have brain threat detectors and the capacity for defense responses, but neither fear as a psychological emotion nor the brain systems needed for emotional feelings.

LeDoux notes that his view is similar to the dictionary definition of emotion as a subjective feeling. He is also not alone among modern psychologists in insisting that emotions must always be conscious, nor in denying emotional feelings to animals. For example, the prominent psychologist Lisa Feldman-Barrett in her recent book on emotion raises the question 'does a growling dog feel anger?', and answers "The answer is almost certainly no. Dogs do not have the human emotion concepts necessary to construct an instance of anger". This rejection of animal emotion resembles LeDoux's, but is on different, more cognitive, grounds. In Feldman-Barrett's view emotion requires the complex cognitive appraisals, language-based reasoning and sociocultural construal's of situations and meaning that only humans possess. This position continues a long tradition of earlier cognitive appraisal theories that reinterpreted emotions as essentially just another type of cognition, turning emotions essentially into cultural-linguistic representations of semantic meaning. Cognitivist academics focus on reasoning and language, and place such a high premium on rationality that they are inclined to see all psychological processes through a purely cognitive lens.

Regarding consciousness, older versions exist in psychology for the notion that emotions must be subjectively felt. The early 1900s position of Sigmund Freud, despite his reputation as father of the psychological unconscious, presaged the modern assertion that emotions are always and necessarily felt. Although Freud held that many psychological processes could be unconscious, he asserted that emotions in particular must always be conscious. Posing the question, "are there also unconscious instinctual impulses, emotions and feelings…?", Freud answers himself no, because "for emotions, feelings and affects to be unconscious would be quite out of the question". Freud did not go on to explain particular reasons for why he believed emotions must always be conscious, when he granted that cognitions, memories and perceptions could all occur in unconscious forms. But after all, Freud's patients were paying him to alleviate their conscious emotional distress.

On the other hand, many contemporary psychologists and affective neuroscientists do believe that affective reactions and emotions can occur unconsciously as implicit processes, as well as subjective feelings. Many have similarly argued that emotions are shared with animals, and that emotional brain systems arose early in evolution, well before human cognitive abilities such as language-based cognition. These views are very well expressed by the distinguished affective neuroscientist Antonio Damasio in a recent book on affect, emotions and feelings. On whether brain systems for emotional feelings are shared with animals, Damasio writes, "Moreover, the emergence of subjectivity is not recent at all, let alone exclusively human. It is likely to have happened long ago, over the Cambrian period". That is, by his view the necessary neural circuitry first evolved several 100 million years ago, being embedded in ancient wiring patterns that are largely contained in deep brain structures below the cortex. And regarding the need to conceptually distinguish between feelings and emotions, despite their overlap in everyday experience, Damasio suggests, "the felt experiences of emotions are unfortunately known by exactly the same name as the emotions themselves. This has helped perpetuate the notion that emotions and feelings are one and the same phenomenon, although they are quite distinct".

My own view is similar: that affective reactions can occur unconsciously, as well as consciously, and that we share many emotional processes and their brain circuitry with animals. But assertions, pro or con, are only an entry point to this discussion. We need reasons and evidence to form adequate conclusions. What is the actual evidence regarding emotions? Is it an adequate theory for psychology to say that animals don't have emotions or that emotions must be conscious?

Quite a lot of evidence actually contradicts contentions that emotions are always subjective feelings, and instead suggests that emotions can also occur even in people without being subjectively felt – at least under some conditions. These emotional reactions occur as core affective processes that can remain intrinsically psychological and emotional, even without conscious feelings, and which have objective consequences and features that can be detected in physiology and/or behavior. However, before sketching that evidence, I should point out one important point of agreement between my view and those of Damasio and LeDoux, despite differences on whether emotion exists in animals or is always necessarily conscious. We all agree it is important to distinguish between subjective emotional feelings and objective emotional reactions. The difference has important implications for understanding normal psychological processes and for understanding psychological disorders.

3.2 PLEASURE

3.2.1 Desires and Rewards

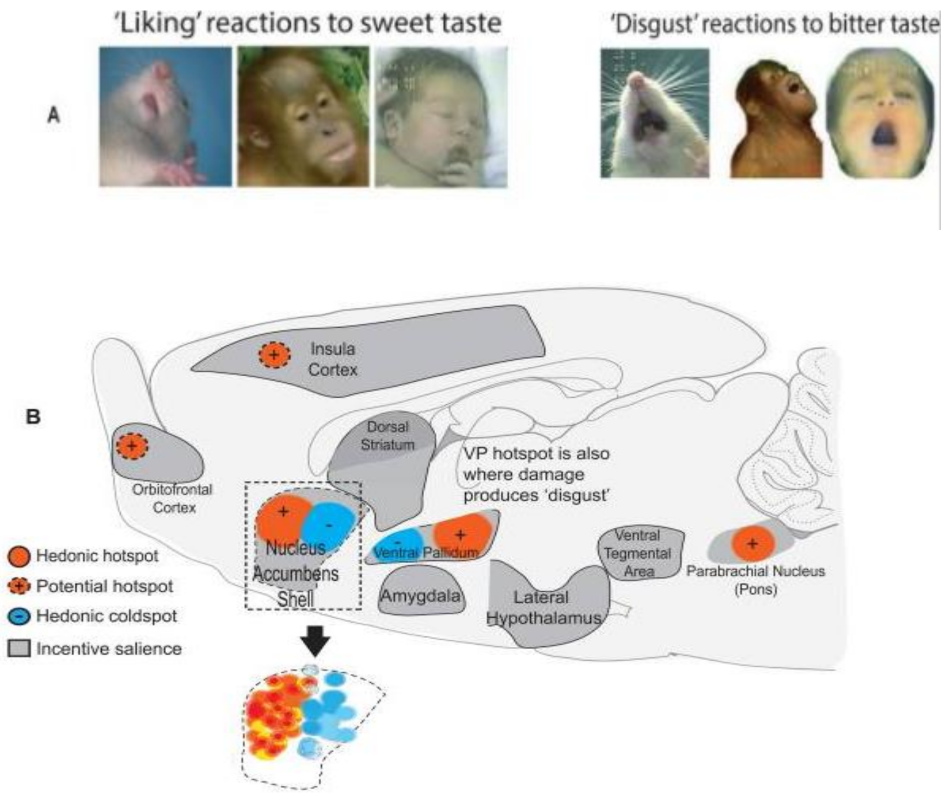
Desires are conative states of mind that are expressed by terms like "wanting", "wishing", "longing" or "craving". A great variety of features is commonly associated with desires. They are seen as propositional attitudes towards conceivable states of affairs. They aim to change the world by representing how the world should be, unlike beliefs, which aim to represent how the world actually is. Desires are closely related to agency: they motivate the agent to realize them. For this to be possible, a desire has to be combined with a belief about which action would realize it. Desires present their objects in a favorable light, as something that appears to be good. Their fulfillment is normally experienced as pleasurable in contrast to the negative experience of failing to do so. Conscious desires are usually accompanied by some form of emotional response. While many researchers roughly agree on these general features, there is significant disagreement about how to define desires, i.e. which of these features are essential and which ones are merely accidental. Action-based theories define desires as structures that incline us toward actions. Pleasure-based theories focus on the tendency of desires to cause pleasure when fulfilled. Value-based theories identify desires with attitudes toward values, like judging or having an appearance that something is good.

Desires can be grouped into various types according to a few basic distinctions. Intrinsic desires concern what the subject wants for its own sake while instrumental desires are about what the subject wants for the sake of something else. Occurrent desires are either conscious or otherwise causally active, in contrast to standing desires, which exist somewhere in the back of one's mind. Propositional desires are directed at possible states of affairs while object-desires are directly about objects. Various authors distinguish between higher desires associated with spiritual or religious goals and lower desires, which are concerned with bodily or sensory pleasures. Desires play a role in many different fields. There is disagreement whether desires should be understood as practical reasons or whether we can have practical reasons without having a desire to follow them. According to fitting-attitude theories of value, an object is valuable if it is fitting to desire this object or if we ought to desire it. Desire-satisfaction theories of well-being state that a person's well-being is determined by whether that person's desires are satisfied.

Marketing and advertising companies have used psychological research on how desire is stimulated to find more effective ways to induce consumers into buying a given product or service. Techniques include creating a sense of lack in the viewer or associating the product with desirable attributes. Desire plays a key role in art. The theme of desire is at the core of romance novels, which often create drama by showing cases where human desire is impeded by social conventions, class, or cultural barriers. Melodrama films use plots that appeal to the heightened emotions of the audience by showing "crises of human emotion, failed romance or friendship", in which desire is thwarted or unrequited.

In our view, a neuroscience of pleasure can be pursued as successfully as the neuroscience of perception, learning, cognition or other well-studied psychological functions. The crucial test of this proposition is: can affective neuroscience produce important new conclusions into how brain systems mediate hedonic impact? Evidence in support of this, we think, now exists in the form of recent findings. In this article we discuss some of these new findings, including 1) separation of reward liking, wanting, and learning mechanisms in mesocorticolimbic circuitry; 2) identification of overlap in neural circuitry underlying sensory pleasures and higher pleasures; 3) identification of particular sites in prefrontal limbic cortex that encode pleasure impact; 4) mapping of surprisingly localized causal hedonic hotspots that generate amplifications of pleasure reactions; 5) discovery that nucleus accumbens (NAc) hotspot and coldspot mechanisms are embedded in an anatomically-tuned keyboard organization of generators in nucleus accumbens that extends beyond reward liking and wanting to negative emotions of fear and disgust; and 6) identification of multiple neurochemical modes within NAc mechanisms that can retune keyboard generators into flipping between oppositely-valanced motivations of desire and dread.

In a sense, pleasure can be thought of as evolution's boldest trick, serving to motivate an individual to pursue rewards necessary for fitness, yet in modern environments of abundance also inducing maladaptive pursuits such as addictions. An important starting point for understanding the underlying circuitry is to recognize that rewards involve a composite of several psychological components: liking (core reactions to hedonic impact), wanting (motivation process of incentive salience), and learning (Pavlovian or instrumental associations and cognitive representations). These component processes also have discriminable neural mechanisms. The three processes can occur together at any time during the reward-behavior cycle, though wanting processes tend to dominate the initial appetitive phase, while liking processes dominate the subsequent consummatory phase that may lead to satiety. Learning, on the other hand, happens throughout the cycle. A neuroscience of reward seeks to map these components onto necessary and sufficient brain networks.



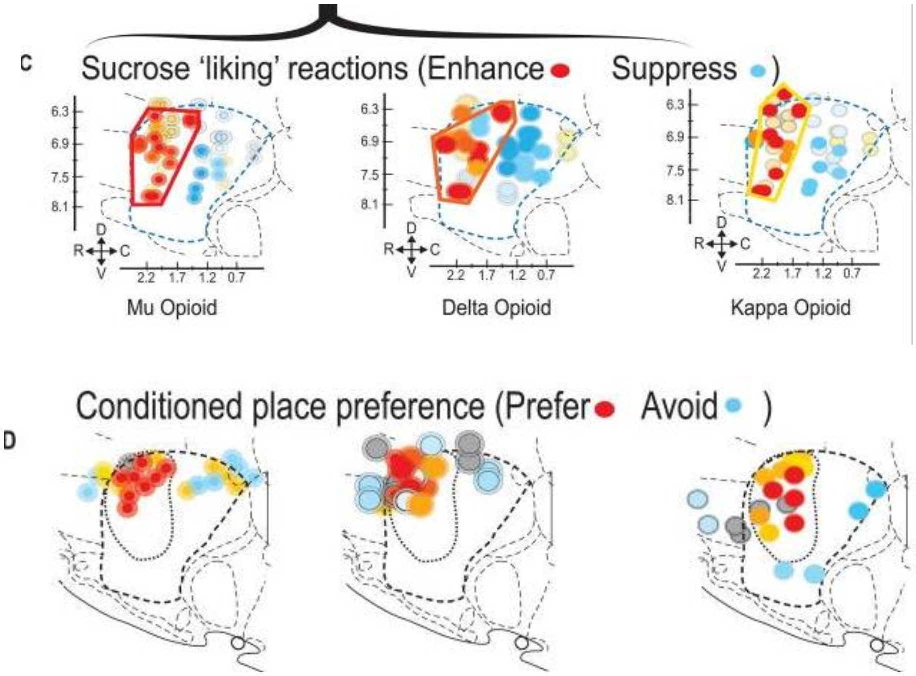


Figure 3.1: Desires and Rewards

3.2.2 Pleasure and Reward

Pleasure is mediated by well-developed meso corticolimbic circuitry, and serves adaptive functions. In affective disorders anhedonia (lack of pleasure) or dysphoria (negative affect) can result from breakdowns of that hedonic system. Human neuroimaging studies indicate that surprisingly similar circuitry is activated by quite diverse pleasures, suggesting a common neural currency shared by all. Wanting for rewards is generated by a large and distributed brain system. Liking, or pleasure itself, is generated by a smaller set of hedonic hotspots within limbic circuitry. Those hotspots also can be embedded in broader anatomical patterns of valence organization, such as in a keyboard pattern of nucleus accumbens generators for desire versus dread. In contrast, some of the best-known textbook candidates for pleasure generators, including classic pleasure electrodes and the mesolimbic dopamine system, may not generate pleasure after all. These emerging insights into brain pleasure mechanisms may eventually facilitate better treatments for affective disorders.

In our view, a neuroscience of pleasure can be pursued as successfully as the neuroscience of perception, learning, cognition or other well-studied psychological functions. The crucial test of this proposition is: can affective neuroscience produce important new conclusions into how brain systems mediate hedonic impact? Evidence in support of this, we think, now exists in the form of recent findings. In this article we discuss some of these new findings, including 1) separation of reward liking, wanting, and learning mechanisms in meso corticolimbic circuitry; 2) identification of overlap in neural circuitry underlying sensory pleasures and higher pleasures; 3) identification of particular sites in prefrontal limbic cortex that encode pleasure impact; 4) mapping of surprisingly localized causal hedonic hotspots that generate amplifications of pleasure reactions; 5) discovery that nucleus accumbens (NAc) hotspot and coldspot mechanisms are embedded in an anatomically-tuned keyboard organization of generators in nucleus accumbens that extends beyond reward liking and wanting to negative emotions of fear and disgust; and 6) identification of multiple neurochemical modes within NAc mechanisms that can retune keyboard generators into flipping between oppositely-valenced motivations of desire and dread.

The term reward system refers to a group of structures that are activated by rewarding or reinforcing stimuli (e.g., addictive drugs). When exposed to a rewarding stimulus, the brain responds by increasing release of the neurotransmitter dopamine and thus the structures associated with the reward system are found along the major dopamine pathways in the brain. The mesolimbic dopamine pathway is thought to play a primary role in the reward system. It connects the ventral tegmental area (VTA), one of the principal dopamine-producing areas in the brain, with the nucleus accumbens, an area found in the ventral striatum that is strongly associated with motivation and reward. Another major dopamine pathway, the mesocortical pathway, travels from the VTA to the cerebral cortex and is also considered part of the reward system. So, the reward system is generally considered to be made up of the main dopamine pathways of the brain (especially the mesolimbic pathway) and structures like the VTA and nucleus accumbens, which are connected by these dopamine pathways.

3.3 BRAIN REACTIONS TO FOOD CONSUMPTION, PATTERNS OF LIKING AND PREFERENCE

Food is required for survival and therefore is a primary reward. Abundance of food has become a greater problem than food shortage: the number of overweight and obese people exceeds that of those suffering from under-nutrition. Obesity is driven by rapid changes in our food environment which promote overeating. Such eating behaviour is maladaptive in the longer term. This review addresses the interactions between foods, the gut and the brain, which give rise to eating behaviour (Fig. 1). With ‘eating behaviour’ we refer to food choice, meal frequency and meal size (where a ‘meal’ includes eating occasions such as eating a snack food or drinking something energetic). Eating behaviour is determined by eating decisions, namely what to eat, when to start and when to stop eating. These decisions are taken in the brain, which integrates a multitude of neural and hormonal signals reflecting internal state and the environment. They determine diet nutrient composition, eating frequency and portion size, i.e., a person’s diet. Understanding how eating decisions come about is crucial for understanding maladaptive patterns of eating behaviour and improvement of their prevention and remediation. Note that eating decisions are usually not made (entirely) consciously, nor are they necessarily the result of ‘free will’.

Relatively recently, neuroimaging techniques such as positron-emission tomography and MRI have enabled studying the brain in vivo. The beauty of MRI is its versatility: many different types of measurements can be obtained with the same machine. In brain research, the most commonly used types of MRI scans are: anatomical scans, showing e.g., grey and white matter; functional (f) MRI scans, either obtained during a task such as looking at food images or during ‘rest’ (resting state fMRI or perfusion scans, which use arterial spin labelling techniques to obtain a semi-quantitative measure of cerebral blood flow; and diffusion-tensor imaging scans, which yield images of the white matter tracts. The most widely used fMRI technique is blood-oxygen level dependent fMRI. This form of fMRI exploits the fact that at a site of increased neuronal firing (brain activation), increased local blood flow leads to a decreased concentration of deoxygenated Hb. This in turn attenuates the local distortion of the magnetic field by deoxygenated Hb, which is paramagnetic, and leads to a small increase in the MRI signal (about 0.5–4 %). Only a small percentage of all fMRI studies involve food-induced brain responses; how- ever, a great deal of neuroscientific work has addressed brain systems intimately involved in, or relevant for, eating behaviors. This includes the neurophysiology and functional neuroanatomy of e.g., sensory perception, reward, emotion and decision-making.

Neuroimaging techniques can be used to measure (changes in) brain state (anatomy, resting state) as well as food cue-induced brain responses. These brain characteristics are affected by multiple traits as well as state factors, such as sex, age and BMI, which in turn modulate eating behaviors. Understanding how eating behaviors is produced requires the integration of neuroimaging data with physiological, psychological and behavioral measures. In particular, linking brain measures to eating behaviors is necessary to be able to interpret neuroimaging findings and assess their real-life relevance. Later, we will review the human neuroimaging literature on the interactions between food, gut, brain and eating behaviors and highlight research needs and techniques that could be used to foster progress.

Food–brain interaction

All senses are involved in the perception of foods and the regulation of food intake. Food perception induces innate and learned autonomic anticipatory physiological responses, which are referred to as cephalic phase responses (for reviews see. In addition to cephalic phase responses, the sensory perception of a food before and during consumption induces numerous brain responses governing food choice and food intake behaviors. Eventually, this results in meal termination and possibly satiety. Of course, once ingestion has started, gastrointestinal neural and hormonal signals also start to contribute. Summaries and detail on the basic processing of food stimuli in the brain can be found in several reviews and meta-analyses ad- dressing visual food stimuli (food images), odour, taste and flavour (taste, odour and somatosensory stimulation).

A well-known phenomenon driven by cephalic stimulation is sensory-specific satiety. Sensory-specific satiety has been demonstrated in the human orbitofrontal cortex for ad libitum consumption. However, further investigation is needed in order to disentangle liking and wanting effects, and assess correlations with eating behaviour (rather than subjective ratings) when there is no ad libitum consumption. Under such conditions it has proven hard to observe sensory-specific satiety effects in the brain.

fMRI studies have shown that anticipation of consumption (food reward) and subsequent consumption (reward receipt) recruit partially different brain areas. The distinction between reward anticipation and reward receipt processing in the brain is particularly relevant for a deeper understanding of aberrant responses to food cues since these could be driven by abnormalities in either one of these processes. For example, neuroimaging studies have shown not only diminished striatal responsivity to reward receipt in obese subjects but also hyper-responsivity to both anticipation and consumption of palatable food in somatosensory, gustatory and reward valuation regions. Interestingly, a recent study found that the association between brain reward responsivity to imagined consumption and weight gain is modulated by genotype.

There can be strong cognitive effects, so-called top- down effects, on food perception and eating behaviors, and this is also studied with functional neuroimaging. A growing number of studies has addressed effects of (selective) attention to specific product characteristics, such as taste and healthiness. Other studies involve neuroimaging of the effects of product appearance or product labels. These topics are addressed further under section 'Cognitive effects.

Gut–brain interaction

The brain receives input from the viscera, including the gastrointestinal tract, and adipose tissue by way of multiple neural and hormonal signals. Most neural information is transmitted by the afferent part of the vagus nerve, which projects to the brain stem where vagal input from each visceral organ is directed to particular subnuclei of the nucleus of the solitary tract as well as integrated with input from other brain regions which regulate autonomic functions and homoeostasis. In addition, many gut peptides and other hormones such as leptin act on vagal afferents, brainstem nuclei and higher brain regions, in particular the hypothalamus, exerting both acute and long- term effects on the regulation of food intake and body weight. Later, work on the relations between stomach distension and hormones and the human brain is reviewed.

Stomach distension

An important determinant of meal termination and satiety is stomach distension by the volume (and weight) of food. To date, surprisingly little studies have investigated the neural correlates of non-painful stomach distension. In neuroimaging studies in which the stomach was distended with a gastric balloon, activation was observed in the brainstem, insula, amygdala, posterior insula, left inferior frontal gyrus and anterior cingulate cortex. Moreover, the response in the left amygdala and insula correlated negatively with changes in fullness and positively with changes in plasma ghrelin. In addition, researcher found that subjects with a higher BMI had a diminished responsivity to stomach distension in the right amygdala and insula. They interpret this as a greater insensitivity to stomach fullness. However, it is hard to rule out differences in stomach volume, which would affect the degree of stretch induced in the stomach wall. Also, a recent animal study has suggested that effects of food-like stomach distension on brain activity may in part be attributable to concomitant transient increases in blood pressure. Future studies should ideally combine fMRI measures of brain activation with MRI measures of gastric volume and data on gastric pressure and stomach emptying, in the case of gastric loads.

Hormones

For studying hormone–brain interaction, there are several options that are only beginning to be explored. The first is to assess which brain areas respond to a particular hormone by infusing it intravenously and assessing effects on base- line brain activity as well as on task-induced activation, e.g., tasting, smelling, or looking at foods. The same can be done by correlating such brain responses to baseline serum concentrations of hormones or to hormone responses induced by a nutrient load. Such experiments have been done for Peptide YY, cholecystokinin, insulin, glucagon-like peptide, ghrelin and leptin. Most of these studies do not link brain (and hormone) responses to actual eating behaviour and this constitutes an important research gap that needs to be ad- dressed if we are to understand the complex interaction between the gut and the brain in relation to (aberrant) eating behaviour. Similarly, the neural effects of 'anti- obesity' drugs can and should be assessed not only in animals but as far as possible also in human subjects.

Modulating factors

Evidently, there are many, often interrelated, factors which affect the brain response to food cues and ensuing eating behaviour. Very basic ones are age, sex, BMI and internal state (hunger/satiety). Both age and sex affect brain structure and function, as well as eating behavior. More specifically, there are many studies showing sex effects on the responses to food, and interactions between sex and internal state. Of course, internal state modulates the (brain) response to food, see e.g., as well as 'resting' brain activity (brain per- fusion).

Many functional studies have shown differences between lean and obese subjects or correlations between brain responses and BMI. In addition, studies looking at grey and white matter volumes (voxel- based morphometry studies) have reported effects of BMI. For example, in obese adults, lower grey matter density was found in brain areas involved in taste perception, reward and behavioural control. Moreover, several studies have linked brain morphology, in particular impairments in the orbitofrontal cortex, with cognitive performance and eating behaviour. To a large extent, it remains to be determined in how far structural and functional differences between lean and obese subjects are cause or effect, and in how far they are reversible. For example, one study demonstrated that brain measures show partial structural recovery with weight loss; however, a functional study has suggested that aberrant responses to food cues persist after weight loss. In line with this, hormone levels continue to deviate in post-obese subjects up to 1 year after weight loss.

Genetic effects

Although functional neuroimaging appears to be a powerful tool to investigate the relations between genes, the brain and behavior, and many polymorphisms have been implicated in obesity, only few neuroimaging studies have addressed specific polymorphisms implicated in body weight control (both on dopamine receptor polymorphisms). A primary reason for this may be that it is hard to obtain enough suitable subjects. An indirect way of selecting for a particular genotype (usually involving multiple genes) may be to select extreme phenotypes. This is in fact what one does, albeit in a crude way, by selecting on extreme BMI. Thus, it may be worthwhile to select on more specific or additional (endo)phenotypic characteristics, such as personality characteristics or measures of eating behavior. For example, it was shown that cholecystokinin and leptin (receptor) polymorphisms are associated with meal size and snacking frequency, which makes these behavioral measures potential selection criteria for a genotype associated with 'overeating'.

Personality characteristics

Evidence is mounting that variation in brain responses can be explained by differences in personality characteristics. Nevertheless, in spite of neural differences the observed behavior can be the same. For example, researcher found that the same behavioral performance was subserved by different neural responses in highly impulsive and highly controlled individuals during a task in which subjects were required to decline immediate rewards.

There are several personality characteristics relevant for eating behavior. These include reward sensitivity, impulsivity and inhibitory potential. How such personality characteristics affect food-induced brain responses has hardly been investigated (one exception is on reward sensitivity). All of them have a bearing on self-regulation capacity and specifically on the ability to resist immediate reward in favor of a longer-term benefit, i.e., on the ability to delay gratification. The neural correlates of self- control, in particular in the food domain, have only been started to be addressed recently and the brain mechanisms underlying conscious as well as unconscious self-control and inter-individual differences therein need to be explored in more detail. This constitutes an important research area since knowledge on these mechanisms, in particular those underlying effortless self-control, could be used to develop more effective ways of improving self- control so as to empower individuals to make healthier food choices.

Cognitive effects

Numerous studies show that food characteristics, such as appearance, packaging characteristics (e.g., labelling) and price, can strongly affect expectations, sensory perception and (eating) behavior. Not surprisingly, this is also apparent in the brain. For example, changing the price label of a wine alters perceived pleasantness as well as taste activation in the medial orbitofrontal cortex. The nature and extent of such cognitive effects may depend on subject characteristics such as BMI or dietary restraint. For example, a low-fat label increased snack intake more in overweight than in lean subjects. Product features affecting perceived healthiness and thereby eating behavior are of great interest because of their bearing on healthier eating patterns. Nevertheless, such features have only begun to be investigated explicitly on the brain level.

Another type of cognitive effect is that of (selective) attention (and distraction) on food-induced brain responses and eating behaviour. Many fMRI studies have shown that selective attention increases brain activation in specific areas for taste, odour and food images. So far, attention effects on brain responses remain to be correlated with eating behaviour, although evidence from non-imaging studies suggests that such correlations should exist. At the same time, these findings underscore that task design and task instruction can have strong attention-related effects on fMRI results.

3.3.1 Drinking and Learning

Most people find that a drink or two before bed helps them fall asleep faster. This may be true. However, as alcohol is metabolized during the night, sleep becomes progressively lighter and more disturbed. Rapid Eye Movement (REM) sleep may also be particularly affected. Disturbances of sleep lead to fatigue and sleepiness during the day. The more one drinks, the faster the person will fall asleep, but the likelihood of sleep disturbances increases. Alcohol consumed up to 6 hours before bedtime can affect sleep patterns, increasing the longevity of disturbances alcohol causes in the body's sleep cycles. Without adequate quality of sleep, a person will feel tired, despite sleeping for 7-8 hours.

The average adult sleeps for 8 hours a night, though different people may "need" more or less sleep. People who do not get enough sleep are more susceptible to:

- Learning difficulties
- Poor concentration
- Coordination/performance issues
- Irritability
- Decreased cognitive abilities
- Memory deficits
- Impaired social and occupational function
- Medical conditions such as heart disease

Implications for Students:

- Information a student studies before drinking is harder to recall
- Harder to pay attention in class and concentrate on work
- When sleep is disrupted a person is more susceptible to depression disorders and a decrease in cognitive abilities. Studies show that normal memory function (learning) is dependent on adequate sleep.
- Heavy drinking often results in missing classes and falling behind in assignments.

Both lack of sleep and alcohol consumption are common occurrences in a college student's life. Many college students are significantly sleep-deprived. The adverse effects of alcohol on sleep magnify this effect. Both of these practices can have negative effects on cognitive abilities, especially when paired together.

3.4 ON BEAUTY

3.4.1 Beauty in the Eye and the Brain of Beholder

Beauty exists entirely in the eye, or rather the brain, of the beholder. This is the central theme of Michael Ryan's, "A Taste for the Beautiful," which focuses specifically on perception of sexual beauty. Sexual signals, often displayed by males, are among the most beautiful and extravagant traits found in nature and have fascinated biologists for centuries. In his book, Ryan tackles the question that has long gripped evolutionary biologists: why would females evolve preferences for such costly traits? Classic hypotheses for explaining female sexual preferences focus on fitness consequences. These traditionally suggest that females prefer elaborate male traits because such traits confer indirect benefits to offspring through good genes, render offspring more sexually attractive, or indicate a male's ability to provide direct benefits such as food or high-quality nesting sites.

Another explanation, sensory bias, posits that female prefer particular sights, sounds, and smells of male sexual signals because the associated neural processing centres became highly developed for reasons other than mate choice, such as finding food or avoiding predators. As one of the primary architects for the concept of sensory bias and exploitation, Ryan falls firmly into the latter camp. He argues that sexual traits evolve by exploiting pre-existing sensory biases resulting from selection for other unrelated ecological tasks. Therefore, to see the full picture of the evolution of sexual preferences, we must consider the underpinning neurological mechanisms. While many evolutionary biologists are already familiar with the idea of sensory exploitation, this book takes a more general, engaging tack intended for no biologists.

One of the book's main themes is that what is deemed beautiful or attractive in one species may be repulsive, or not even perceived, in another—beauty is entirely subjective. As Ryan puts it, "I find the Mona Lisa beautiful, and perhaps you don't. We both see the same arrangements of collars within the frame; we just process them differently". Each individual is a unique combination of neural circuitry and behavioural traits that ultimately decides what is beautiful. Using vivid imagery, Ryan makes this point by showcasing taxonomically diverse examples of animal communication across a number of sensory modalities. Readers are invited to marvel at the majesty of a Bowerbird's lair, listen to a cricket's charming song, and smell the perfume of an orchid bee, while simultaneously learning how each species' brain and sense organs process this information. The examples are enhanced by a series of stunning plate photographs. Ryan's discussion of the evolution and perception of sexual beauty also masterfully cuts across the organizational scale of living things, jumping between genes, cells, sensory systems, and organisms. This is best evidenced by his engaging description of the sexual preferences of the Tungara frog, which ranges from describing the role of genes to sensory organs to behaviour as they relate to the frogs' whine-chuck system.

Because this is Ryan's primary study species, he also includes interesting "behind the scenes" details to explain how the research unfolded. Ryan tackles his argument in threefold, providing examples of visual, acoustic, and olfactory signalling systems and discussing the brain's importance in processing these signals. However, while he makes a clear case for the need to include the brain's role in the story of sexual signal evolution, only occasionally are these neurological mechanisms discussed in detail. More often than not, he simply describes examples of different animal signalling systems while the underlying reason for the sensory bias is not revealed. Certainly though, these tales of different signalling systems and female mating behaviours are fascinating and provide the reader with a deeper appreciation for the diversity of sexual beauty. Ryan also emphasizes that existing biases could lead to future exploitation and explains how there are many potentially untapped ways to exploit these existing biases, akin to an "artist experimenting with paint on a canvas or a musician tinkering with new combinations of beats and chords".

That last step however, of connecting a signal to its respective sensory bias origin, often remains elusive. One could argue that this shortcoming is in fact the point of his argument—that there has not been enough fieldwide emphasis on the ecological basis of neurological biases to provide many strong empirical examples. In making the case that the brain drives evolution of sexual beauty through sensory bias, Ryan downplays the importance of alternative hypotheses, asserting that the good genes and runaway hypotheses have not received the same level of empirical support as sensory exploitation. Sensory drive (an expanded version of sensory bias that includes the role of the signal transmission environment in affecting sensory and signalling traits) has in fact enjoyed substantial, albeit somewhat mixed, empirical support. However, these hypotheses are not mutually exclusive and may all at least partially contribute to the evolution of sexual signals and preferences. For example, one of the most famous tales of sensory exploitation is that of the orange coloration of male guppies that appears to mimic a common food item. Because the female guppy sensory system is already finely tuned to prefer orange due to this foraging preference, females are also attracted to orange coloration during mate choice. At the same time, other research demonstrates that the carotenoid-based orange coloration of male guppies signals indirect benefits and is correlated with offspring foraging ability and success at evading capture. Ultimately, more research is required to understand the relative importance of and potential synergies between the different proposed evolutionary mechanisms of female mate choice. Though "A Taste for the Beautiful" does not provide the winning case for sensory bias, this does not mean that Ryan's message fails to deliver. He makes the described concepts relatable to anyone reading the book by weaving together diverse topics from economic theory to Cinderella's Castle at Disneyworld.

One particularly effective way that he makes his book accessible is by including many human examples, woven almost seamlessly into his thorough exploration of the animal kingdom. In general, the discussion of human evolution is well executed, with interesting insights into communication within our own species, from visual attributes of written languages to mate choice copying. However, discussing human evolution can be a double-edged sword. A few controversial examples of evolutionary psychology are not explained with enough nuance, such as of the oft-debunked story of exotic dancers making more tip money when ovulating. This may give such examples disproportionate weight, particularly for those unfamiliar with the controversy. The final chapter of the book also includes a section on pornography and sexual fetishes that some readers may find a rather unsettling note to seal lasting impressions of the book. Overall, "A Taste for the Beautiful" is an engaging read that we would recommend for undergraduate Biology majors, graduate students, and others with a background in biology. Though the book is intended for a general audience, it may not be fully suited for the average reader. At times, it becomes rather technical, explaining particular genes or neural pathways in detail and using acronyms that are common for researchers in a field, but can be intimidating for others.

Some of the theories discussed will be familiar to non-scientists (such as Pavlovian conditioning, best known in the context of Pavlov's dog), but are occasionally made unnecessarily complex by describing them with excess jargon. At the other end of the reader spectrum, this would be a fun read for professional evolutionary biologists, though probably not a book to cite in academic research. That said, Ryan is a masterful writer, pulling from multiple sensory modalities and an innumerable number of species to construct the case that all roads lead to the brain. His language is both profound and relatable, with vivid imagery and casual humour that draws in the reader. This delightful and illuminating book is sure to deepen one's appreciation for how the brain shapes evolution of sexual beauty.

3.4.2 Angular or Round?

In real life, everyone's face shape is beautiful and uniquely different, and there are so many little variations in shape and size. To keep things simple, however, we like to break them down to the 5 of the most common face shapes. These five face shapes are:

1. A heart face shape
2. A square face shapes
3. An oval face shapes
4. A rectangle face shape (a.k.a. a diamond face shape)
5. A round face shape

Your cheekbones, jawline, forehead, the length of your face, and the width of your face all determine which category you fall into. But unless you're Reese Witherspoon (with that cute heart shape), the shape of your face isn't always immediately obvious. Your face might even be a combination of one or two of these face shape categories.

We break down what each of these face shapes look like below, so you'll know what to look for when you're figuring out your own.

Every Single Face Shape, Explained:

1. Heart Face Shape

People with heart face shapes have a slightly pointy chin, wide forehead, and generally a more angular jawline, making the face resemble–you guessed it–a heart shape. "You're the real deal heart shape if you have a widow's peak in addition to the above," says global makeup artist Leiah Scheibel.

2. Square Face Shape

If the length of your face is about equal to the width of your face, and your jaw is angular instead of rounded, your face shape is square. "Cheekbones on a square face will be parallel to the hairline and jawline," says Scheibel.

3. Oval Face Shape

Oval shapes are defined by an oblong form. "Oval face shapes generally, are longer than they are wide, with wider cheekbones than the rest of the face," says Scheibel. "The jawline doesn't come to point but is very narrow and rounded."

4. Rectangle Face Shape

Similar to square face shape, people with rectangle face shapes have an angular, strong jawline. Unlike square face shapes, though, oval face shapes are longer than they are wide. " The cheekbones on a rectangle face will be no wider than the forehead and jawline," adds Scheibel.

5. Round Face Shape

For those who have round faces, the widest part of your face will be your cheekbones, while the forehead and chin are rounded out. "Cheekbones will be the widest part of the face on a rounded shape," says Scheibel.

3.4.3 Beautiful Sounds

Bob Dylan turns up at the MusiCares Person of The Year Awards in Los Angeles, where he is due to be honored, with a 30-minute homily tucked inside his jacket pocket. Musicians and industry honchos who have aided and abetted his career and generally inspired him are cordially acknowledged – then he uses the opportunity to settle some long festering personal grievances.

'Critics say I can't carry a tune and I talk my way through a song,' the 73-year-old folk warrior snarls, before drawing some serious blood. What justice in a world where he, Bob Dylan, must endure regular critical slap downs for a voice that apparently sits at the very point of disintegration, with shaky diction and lucky dip tuning, when throwing comparable critical missiles in the direction of Lou Reed or Dr John would be unthinkable? 'You have to wonder if these critics have ever heard Charley Patton or Son House or Howlin' Wolf,' Dylan adds as a rider, invoking the ghosts of some long-departed delta blues singers to back his cause.

And within minutes of those words leaving Dylan's mouth earlier last month, the anti-Dylan naysayers were quick to pounce. From his position of unassailable power within what is left of big business, major label music, Dylan had managed to twist what ought to have been a celebration into a needlessly bitter, bad-mouthing occasion. With his new album to push, was he on a mission to generate headlines? Probably. Especially as said new album, Shadows in The Night, is his homage to Frank Sinatra, an improbable prospect in the extreme likely to reveal, if anything would, how rough and ready Dylan's voice is in comparison to Sinatra's cannily choreographed crooner velvet: being in tune a virtue next to godliness, each note immaculately enunciated.

In reality, though, Shadows in the Night is all about Dylan's genius for transforming any song he chooses to snare into a meaningful, distinctive personal vehicle. And while it's true, the section of his speech I quote above is surprisingly clumsy – sorry, Bob, but it is – the reason why nobody is minded to say much against Lou Reed is that he died two years ago; and a swanky Tinseltown ceremony might not be the best place to claim allegiance with some of the most disadvantaged people ever to have committed their voices to disc – Dylan has every right to feel seriously aggrieved about those unthinking, sneering words about the supposed deficiencies of his voice that regularly fill the column inches.

His speech dispensed a stark, barbed repudiation of a critical position that, over many years, has solidified into a self-perpetuating 'truth'. The idea that Dylan's voice is unpalatable to the ear has become a crude caricature, up there with the popular mythology surrounding Roger Moore acting, supposedly, via the expressive muscle of a quizzically raised eyebrow – on a good day eyebrow. But Roger, we love you. Carrying off the pristine white of a Safari suit takes more than an innuendo-laden face tic. And dismissing the Dylan of the last two decades or so simply because he doesn't sound now like he did during his mid-1960s flush of youth is equally reductionist and judgmental.

But what has Dylan's acceptance speech, his new album and the peculiarities of his singing voice got to do with Gramophone-world? Typified by Dietrich Fischer-Dieskau or Janet Baker, you may feel that his work has precisely nothing to do with vocal utterance as this magazine understands it, but I would like to propose that Dylan's address ought to make anybody who considers themselves to be a lover of music, and therefore sound, stop and think. Knowingly or otherwise, Dylan is rekindling an argument with deep philosophical roots in Kant, Hegel and Schopenhauer. What exactly is a beautiful sound? And who are you to say that your sense of what is – and therefore isn't – beautiful holds greater weight and certainty than the equally passionately held conviction of anybody else? Dylan's words oxygenate an argument that is often nonchalantly swept aside. Classical music buffs know instinctively what beauty is, because, well it's obvious…isn't it?

I have written before – too often probably – about the German composer Helmut Lachenmann and his philosophy of the beautiful, but quite honestly, I live for mornings like this when I can segue seamlessly between Bob Dylan and Helmut Lachenmann via Roger Moore. 'It's very easy to write so-called "expressive" music using old patterns,' Lachenmann once told me. And the ideal of the beautiful he proposes holds in distain faux-convincing 'beautiful sounds' that work only at the level of cosmetic decoration.

During our 2002 interview, he drew a comparison between two visual extremes: manufactured, airbrushed photographs of Madonna and images of Marlene Dietrich taken during her twilight years. The market would like us to buy (literally) into the idea that Madonna's sexualised curves and flawless skin is 'beautiful'. Sex sells and beauty, apparently, equates to physical perfection. But the persona of Madonna (as distinct from Louise Ciccone) is a product and such photographs are revealed to be an infantile illusion. Whereas the honest wrinkles and dignity of Marlene Dietrich have a beauty that is unaffected and therefore undeniable.

As a rule of thumb, art has a duty – although not necessarily – to offer more than unmediated sound and image. Lachenmann drew an analogy between his (then young) daughter and JS Bach: 'If I want to understand what's going on in the mind of my little daughter,' he said, 'better for me to observe how she writes a letter or how she sits on a chair than to ask her. If I ask, she has to find vocabulary to articulate or even hide her thoughts and feelings; but by observing I can see immediately what's going on inside her mind.' Lachenmann explained that in his Inventions, Bach manipulates motifs built around five fingers, asking us to observe how '(through) his creative intelligence and effort the work is a message of human spirit and freedom.'

The point being, I think, that beauty invariably comes loaded with terms-and-conditions. One stricture that British so-called 'light music' (the work of Eric Coates, Ronald Binge, etc) shares with the neo-Modernism of a Richard Barrett or Rebecca Saunders is that a pre-compositional decision has already been taken that this music, whether it wants to or not, must exhibit Category A 'lightness' or create a designer 'modern' sound – which means musical material must be tailored to fit an existing idea of what it ought to be. Leeway for that material to be itself, to occupy comfortably its own skin, or to discover during the act of creation what it might aspire to be, is severely curtailed.

But this philosophical backchat would mean little if nothing were to change in sound. A straw poll that posed the question 'what is a beautiful musical sound?' would likely throw up a smorgasbord of musical bon-bons from Delibes's Flower Duet and a selective view of Mozart and Beethoven (the Moonlight Sonata, yes, the Hammerklavier less likely) through to Hit Parade ditties by Chris De Burgh and James Blunt, leaving those of who genuinely get our jollies from the bracing sublimity of Lachenmann, Ustvolskaya, Xenakis, David Tudor, or the free jazz of John Coltrane and Cecil Taylor, to wonder why we have been left out of this particular beauty pageant.

Music has nothing to fear from sound. The sonic firepower of orchestras, choirs, nimble-fingered instrumentalists, and the theoretically limitless resources of electronics, ought to leave our ears begging for more. But the protectionist culture that surrounds classical music – if not the music itself – places squeamish barriers around sound. Beauty being synonymous with smooth delivery; with mathematically pure symmetry; with harmony that resolves rather than leaves itself hanging, is hard-wired inside impressionable brains from those very first music lessons when, to execute a flawless C major scale, we are taught that the thumb must be tucked under the third finger in time to reach the F. Beauty leans on technique; the exquisitely proportioned melodic line of the Flower Duet relies on two singers who are unerringly in tune; the Moonlight Sonata's opening movement must flow like ripples across a pond.

And assuming those ripples don't splash over into interpretive mannerism, there is of course absolutely nothing wrong with allying music to the appropriate technique. But when composers are minded to start rearranging the basic molecules of technique – hinting those other definitions of the beautiful might be possible too – that is where problems of perception can begin.

3.5 COORDINATED ROLE OF SENSES IN ENHANCING POSITIVE EXPERIENCE

3.5.1 Joint Influence of Visual and Audio Stimuli

The principle of audio-visual stimulation is based on the stimulation of the central nervous system with specific visual and audio signals. These signals influence the brain in various ways depending on the sounds delivered by the headphones and the light signals that are displayed over one's entire field of vision by the LED mask.

Imagine the calming effect of a flickering, crackling camp fire. With the right settings, Mind Lights' effects on your mental state are similar but are much more powerful and specific. Beyond this, there are many different areas of application.

Figure 3.2: AVS

Uses

Mental fitness and vitality:

- Increased concentration, perception and memory
- Overcoming tiredness and exhaustion

Relaxation and stress management

- Induces deep relaxation
- Increases stress resistance

Meditation, mentral training, trance & hypnosis:

- Inducing meditative and trance-like states
- Promotes creativity
- Use of hypnagogic state for auto-suggestion and affirmation

Sleep:

- Overcoming problems with falling- and staying asleep
- Promotion of healthy and refreshing deep sleep

Theraputic uses in:

- Stress disorders and nervousness
- Tinnitus
- ADD und ADHD
- Symptoms of dementia
- Depression and anxiety problems
- Pain (especially fybromyalgia)
- Blood pressure
- Sleep disorders

3.5.2 Commonality of Senses: Odour and Music

Researchers have demonstrated that olfactory perception can be influenced by inputs from the other senses presented prior to and/or at the same time. In fact, a variety of cross modal correspondences—the name given to the tendency for people to match the information presented in one sensory modality to that presented in another—have been documented between olfaction and the other senses. So, for example, to date, cross modal associations have been demonstrated between odors and pitch, brightness, colors, basic tastes, and even tactile stimuli.

Researcher recently suggested that people may use descriptors or attributes that are normally associated with other sensory modalities such as pitch, brightness, and sweetness to describe olfactory stimuli/percepts because of the various cross modal correspondences that exist between the senses. It is interesting to note, though, that the cross-modal interactions that link olfactory and auditory stimuli have received far less attention than, for example, those that exist between vision and audition. Nonetheless, over the last couple of decades, researchers have started to document the existence of a number of cross modal correspondences between olfactory and auditory stimuli. For instance, Researcher provided one of the first examples of olfactory–auditory correspondences, showing that people would match a series of odors varying in quality, to sounds that differed in terms of their pitch. These results were later extended by researcher who also found that people tended to match certain odors to the timbres of particular musical instruments.

While the cross modal correspondence between specific olfactory stimuli and, say, particular colors could be explained by their co-occurrence in foodstuffs (think only of the red color of strawberries and the associated aroma), it is far harder to think of an environmental explanation that could explain why people would reliably (or consistently) associate specific musical parameters with particular olfactory stimuli and why these associations would, in turn, influence information processing. In their recent review, Researcher suggested that one potential explanation for the existence of cross modal correspondences between auditory and olfactory stimuli may sometimes be related to the hedonic properties of the stimuli presented in the two modalities. As indicated, sensory qualities "talk over their common feeling." This notion has also been supported by recent research pointing to the idea that the emotional (hedonic) similarity between olfactory and auditory information may be crucial to both cross modal correspondences and multisensory information processing.

Researcher reported two experiments in which they assessed the effect of auditory stimulation on the perceived pleasantness and intensity of odors. In their first study, they investigated whether auditory cues that were semantically congruent with the olfactory stimuli (sounds that were crossmodally better matched to the odors, i.e., the smell of potato chips while listening to the sound of crunching crisps) would modulate the perceived intensity and pleasantness of the odor. In their second experiment, the authors evaluated whether odor intensity and pleasantness could be influenced simply by manipulating the hedonic valence of the auditory stimuli.

Researcher reported that olfactory stimuli (such as the smell of coffee) were rated as more pleasant when paired with congruent sounds (i.e., when listening to the sound of drinking coffee in this example) as compared to incongruent sounds, and that the hedonic valence associated with the sounds can be transferred crossmodally, and thus influence people's odor evaluations. Interestingly, however, no cross-modal effect on the perceived intensity of the odors was reported. Researcher suggested that the results of their first study may have been attributable to the existence of a cross modal congruency effect, while the results of their second experiment could be explained in terms of some form of halo/horn effect. This evidence points to a hedonic similarity account. It may be the case that there is a cross modal transfer of the hedonic evaluation of the information presented in one sensory modality onto the information processed in the other.

Researcher recently extended results to more abstract auditory cues. In three experiments, the authors demonstrated that people match a variety of odors and background music, that congruent (to odors) background music (i.e., Christmas carols) would enhance the rated pleasantness of certain odors, and that congruent sounds had an impact upon odor familiarity and identification. For example, participants liked the smell of cinnamon more when it was presented together with (congruent) Christmas carols as compared to incongruent sounds. The authors suggested that the association between cinnamon and Christmas is very typical for the German participants whom they tested. The statistical regularities of the environment and co-occurrence of multisensory stimuli can thus lead to specific crossmodal associations.

Further research is still needed in order to clarify the potential influence of auditory cues in odor perception, and its underlying mechanisms, since the crossmodal interactions between these senses are likely to operate at various different levels of human information processing. In the present study, we aimed to assess any effect of the pleasantness of the music on the perceived pleasantness and/or intensity of the odors. In addition, we also wanted to assess whether having congruent (vs. incongruent, in terms of the perceived pleasantness) auditory and olfactory stimuli would influence the perception of other odor qualities such as sweetness, brightness, acidity, and dryness, which are attributes commonly used to describe fragrances and have been shown to be crossmodally associated to odors.

In the present study, we manipulated the crossmodal congruency based on a matching of the hedonic qualities of the stimuli. There is an intriguing question here as to whether and why changing what one hears can change an observer’s experience of an olfactory stimulus. There is a need to clarify both the nature of the specific associations that exist between odors and sounds, and the influence that auditory cues may exert on the perception of odor attributes in, for example, the case of fine fragrances.

3.5.3 Touching Products....

They help differentiate brands, bring them to life in new ways, offer the ultimate brand experience, increase visibility and support other sales channels as part of an omnichannel system.

3.5.4 Sharpening the Senses

Smell

1. Scent therapy

Trying what certain doctor's name as "Inhalation of a strong smell" can kindle new receptors in your nose which enhances the sense of smell over the time. Pick a few strong smells every day which you may like and sniff them for some time. Doing this regularly will help you recognize these smells much easily within a week's time.

- Essential oils are good choices when it comes to scent therapy. Pick 3 or 4 such oils like lemongrass, rose, cedar, geranium and Vanilla.
- Certain raw materials are good to use for scent therapy. Fill few items with a strong smell in jars like ground coffee, spice leaves, pleasant smelling shampoo and smell them frequently. Keep the lids of the jars tightly closed when you don't smell to keep the smell strong.
- Remember to sniff quickly when practising scent therapy rather than inhaling every scent deeply. This helps in avoiding scent fatigue.

2. Keep your eyes closed and inhale

Another way of therapy which can be experimented on is to identify the different variety of smells by keeping the eyes closed. Performing this therapy over a few months will help you develop your capacity to distinguish between various smells. Just keep your eyelids close and make people hold various substances near your nose. Sniff and identify the substance.

- Try with a bit different variety of smells like cocoa, cinnamon, vanilla, orange and mint. Rotation of such different smells enhances you smelling sense.

- As you improvise in differentiating the smells, begin experimenting with bit complex scents which are difficult to recognize like cherry, grapefruit, lime and many more.

3. Describe smells out loud

As you recognize and elaborate the smell out in a loud voice, your capacity to perceive it is strengthened. Attempt to talk about the smells as you feel them. Describe the smell openly in any language, just like a wine connoisseur who would describe the quality of various wines.

- Make it a practice to notice and speak about the smells you come across every day. For example, discuss the nuances of the smell you come across at a dinner table. “The scent of earthy churned corn in the tortillas, the sweet and spicy flavour of pork filling, the cilantro smells fresh soapy and the lime smells floral citrus”.

Tasting

1. Lower Salt and Sugar

Eatables laden with these two flavours can mess your taste buds. The salt and sugar flavour cover up the subtle flavours and make it difficult for us to enjoy the actual taste of the food. When you cut on these basic flavours initially you will find it difficult but after few days you happen to notice that you were actually missing on few complex flavors and you begin to enjoy them.

- Just plan your salt and sugar content in the food by lessening it to 1/3 or 1 /2. Sugar can also be substituted with honey which is a bit less intense.

- Salt need not be totally taking away from your food. Minimum amount salt actually enhances the taste of the food that you cook. But when you sprinkle too much of it on everything it begins to fade the actual sense of taste.

2. Keep away from Processed Foods

Processed foods are usually packed with sugar and sodium content which is a major reason to keep you away from them. The artificial flavors and chemical content may spoil the sense of taste. Chewing up sweet and spicy crunches from a fast-food corner may actually fade your taste buds as you will be prone to chemically enhanced food flavours. Retain the sense of taste by choosing subtleties filled with natural flavours and keep yourself away from processed and chemical flavours.

- Snacks such as chips, toffees and sodas are specifically flavour blasts which kindle your brain's tasting pleasure and boost the cravings. Rather than this, homemade popcorns sprinkled with pepper and salt or homemade soda or fruit juice can be best for a tea break.

- Initially, it will be difficult to adapt but later natural flavours will be more relishing than any other artificial taste enhancers.

3. Smell your food before you eat

The senses of smell and taste are quite interlinked with one another. When the smell is sharpened taste automatically enhances. So, the trick of better taste is to inhale the smell of the food before your tummy tucks in the meal.

Seeing

1. Take in food which keeps your eyes healthy

Food with Vitamin A, Vitamin C, and Vitamin E are very good for vision. Consuming food rich in these vitamins is the first step towards sharpening the sight. Foods rich in beta-carotene, lutein and zeaxanthin are also very essential for eyes as these antioxidants safeguard the eyes from sun damage.

- Include dark green leafy veggies, sweet potatoes, carrots and also peppers in your diet.

- Moreover, antioxidants that protect the eyes are filled in foods like blueberries, garlic, shallots, onions and grapes.

- Foods which have DHA and fatty acid help in keeping up a healthy eye. Salmon, mackerel, cod and sardines provide essential nutrients for a healthy eyesight.

2. Things to note at work for eyes

- Straining your eyes much at your workplace while performing your job requirements may spoil the eyesight over time.

- It is absolutely necessary to take necessary breaks in between and look away from the computer so that the eyes get relaxed after a continuous strain of looking at the flickering lights in the computer.

- After every hour just get up from your workstation and look outside at the natural light, gaze at some sights far away if possible. Just keep your eye on it till your sight adjusts to the view.

- **3. Eye exercises**

Simple eye exercise as a part of your daily regime can give magical results in sharpening your eyesight. Practice the exercises daily especially when your eyes feel tired and a break from the daily routine with such exercises is a must.

- Rotate your eyes around. Look above, then on the sides, then below and then to another side. Repeat it about ten times.

- Keep your focus on an item, keep it near your face and then slowly move it back with your eyes focused on the object. Then repeat it by moving the item close to you again for about 10 times.

- Keep a check on your peripheral vision. Stand looking at the wall focusing straight ahead. Try to recognize what is there on both your sides with the help of peripheral vision. Move ahead close to the wall and keep up your peripheral vision. Continue this task till your side views are obstructed. Practice this for a few days and slowly your peripheral vision will develop.

Hearing

1. Red wine for Ears

Red wine has resveratrol which is an antioxidant that enhances the hearing ability. Sipping a glass of red wine, especially on a daily basis may be every evening improves the capacity to hear over a period of time.

2. Ear-friendly Diet

There are certain foods which will help you to keep up your hearing capacity good with your increasing age. The nutrients in certain food items are essential for your Ear health. Get to know them!!

- The blood flow in the ear passage improves with food rich in omega

3 fatty acid and it helps with good hearing capacity.

- Inflammation in inner parts of the ear can be reduced by including food with zinc content in your diet.
- Quercetin present in apples is an antioxidant that helps in curing the free radical damage.

3. Music for Hearing

Listening to music at low or medium sound can sharpen the hearing capacity. Pick music which has elements that quite different from one another, this helps in focusing on a particular instrument at one time. Keep your concentration fully on music this helps in differentiating the movements and sounds.

- Jazz is a good pick for improving the hearing capacity as musicians change instruments and play in solo.
- Never increase the music beyond the medium volume. The sound of the music has to be such that you are able to have a conversation without any disturbance.
- Hearing music doesn't call for attending noisy concerts which in fact reduces the hearing ability. The same applies to ears prone to noisy traffic on a highway or a machinery sound etc. Earplugs and headphones are the best remedies for keeping away from the noise at such places where there is the high volume of sound.

Touching

1. Keep an eye on What you are touching

It is been scientifically proven that tactile sense and vision are interlinked. So when you keep an eye on the object while you are touching it enhances your touching sense. When the item you are touching is an interesting stuff for you do pay attention to how it looks like, this helps you feel the object better.

2. Give more attention to How things feel

The sense of touch is the one which is taken for granted at most times. Specifically giving some attention to how you feel when you touch something helps you to improve your touching sense as it triggers the brain and the touch sense is stimulated. Apparently, begin to pay attention to what your skin is touching.

- As you shop for dresses do run your fingers over the different texture of fabrics. Try to differentiate between various cloths such as cotton and polyester, silk and satin. Do make a choice based on the cloth that feels best on your skin.

- Try to deliberately touch on different textures the entire day. Give your fingers an opportunity to graze a rough surface as you walk by and also touch a soft flower. Also, run your fingers through the strands of your hand and also touch your skin beneath your toe. Such a difference in the surface you touch kindles the sense of touch.

- Moreover, do keep yourself away from certain natural factors that tend to change the feel of your skin like sharp sunshine and cold breeze.

3. Pamper your skin

Soft skin tends to be more sensitive than rough skin. Presence of callouses in hands or legs may limit the sense of touch and feel. Consider using a pumice stone which will get away with the rough edges of the skin and moisturize the skin with oil or lotion. This helps in improving your skin texture to being soft and also sensitive.

- Give an all-around exercising and movement to your body is essential. Dancing, yoga, running and having good messages such as acupuncture sessions support in keeping yourselves in tune with your physique. Such exercising regimes help you keeping yourselves physically awake.

Having all your major 5 senses supercharges helps you enjoy your life to the maximum with your physical body supporting you in all ways. To keep it in tune with the fast-paced life, sharpen and refresh the major 5 senses.

In simple words, the key to unlocking your five senses is to question t yourself the need of the sense. Just give a minute of thought about why you want to see, hear, taste, smell or touch something? If you answer it, you will absolutely get the importance of these senses and start following few tips from above for a better lifestyle.

3.6 EMOTIONS, MOOD AND BEHAVIOUR

In contrast to emotions or feelings, moods are less specific, less intense and less likely to be provoked or instantiated by a particular stimulus or event. Moods are typically described as having either a positive or negative valence. In other words, people usually talk about being in a good mood or a bad mood.

Mood also differs from temperament or personality traits which are even longer-lasting. Nevertheless, personality traits such as optimism and neuroticism predispose certain types of moods. Long term disturbances of mood such as clinical depression and bipolar disorder are considered mood disorders. Mood is an internal, subjective state but it often can be inferred from posture and other behaviors. "We can be sent into a mood by an unexpected event, from the happiness of seeing an old friend to the anger of discovering betrayal by a partner. We may also just fall into a mood."

Research also shows that a person's mood can influence how they process advertising. Mood has been found to interact with gender to affect consumer processing of information

1. Positive mood

Positive mood can be caused by many different aspects of life as well as have certain effects on people as a whole. Good mood is usually considered a state without an identified cause; people cannot pinpoint exactly why they are in a good mood. People seem to experience a positive mood when they have a clean slate, have had a good night sleep, and feel no sense of stress in their life.

There have been many studies done on the effect of positive emotion on the cognitive mind and there is speculation that positive mood can affect our minds in good or bad ways. Generally, positive mood has been found to enhance creative problem solving and flexible yet careful thinking. Some studies have stated that positive moods let people think creatively, freely, and be more imaginative. Positive mood can also help individuals in situations in which heavy thinking and brainstorming is involved. In one experiment, individuals who were induced with a positive mood enhanced performance on the Remote Associates Task (RAT), a cognitive task that requires creative problem solving. Moreover, the study also suggests that being in a positive mood broadens or expands the breadth of attentional selection such that information that may be useful to the task at hand becomes more accessible for use. Consequently, greater accessibility of relevant information facilitates successful problem solving. Positive mood also facilitates resistance to temptations, especially with regards to unhealthy food choices.

Positive mood has also been proven to show negative effects on cognition as well. According to the article "Positive mood is associated with implicit use of distraction", "There is also evidence that individuals in positive moods show disrupted performance, at least when distracting information is present". The article states that other things in their peripheral views can easily distract people who are in good moods; an example of this would be if you were trying to study in the library (considering you are in a positive mood) you see people constantly walking around or making small noises. The study is basically stating that it would be harder for positive moods to focus on the task at hand. In particular, happy people may be more sensitive to the hedonic consequences of message processing than sad people. Thus, positive moods are predicted to lead to decreased processing only when thinking about the message is mood threatening. In comparison, if message processing allows a person to maintain or enhance a pleasant state then positive moods need not lead to lower levels of message scrutiny than negative moods. It is assumed that initial information regarding the source either confirms or disconfirms mood-congruent expectations. Specifically, a positive mood may lead to more positive expectations concerning source trustworthiness or likability than a negative mood. As a consequence, people in a positive mood should be more surprised when they encounter an untrustworthy or dislikable source rather than a trustworthy or likable source.

2. Negative mood

Like positive moods, negative moods have important implications for human mental and physical wellbeing. Moods are basic psychological states that can occur as a reaction to an event or can surface for no apparent external cause. Since there is no intentional object that causes the negative mood, it has no specific start and stop date. It can last for hours, days, weeks, or longer. Negative moods can manipulate how individuals interpret and translate the world around them, and can also direct their behavior.

Negative moods can affect an individual's judgment and perception of objects and events. In a study done by researchers, research showed that individuals are tuned to perceive things that are congruent with their current mood. Negative moods, mostly low-intense, can control how humans perceive emotion-congruent objects and events. For example, Niedenthal and Setter land used music to induce positive and negative moods. Sad music was used as a stimulus to induce negative moods, and participants labeled other things as negative. This proves that people's current moods tend to affect their judgments and perceptions. These negative moods may lead to problems in social relationships. For example, one maladaptive negative mood regulation is an overactive strategy in which individuals over dramatize their negative feelings in order to provoke support and feedback from others and to guarantee their availability. A second type of maladaptive negative mood regulation is a disabling strategy in which individuals suppress their negative feelings and distance themselves from others in order to avoid frustrations and anxiety caused by others' unavailability.

Negative moods have been connected with depression, anxiety, aggression, poor self-esteem, physiological stress and decrease in sexual arousal. In some individuals, there is evidence that depressed or anxious mood may increase sexual interest or arousal. In general, men were more likely than women to report increased sexual drive during negative mood states. Negative moods are labeled as nonconstructive because it can affect a person's ability to process information; making them focus solely on the sender of a message, while people in positive moods will pay more attention to both the sender and the context of a message. This can lead to problems in social relationships with others.

Negative moods, such as anxiety, often lead individuals to misinterpret physical symptoms. According to Jerry Suls, a professor at the University of Iowa, people who are depressed and anxious tend to be in rumination. However, although an individual's affective states can influence the somatic changes, these individuals are not hypochondriacs.

Although negative moods are generally characterized as bad, not all negative moods are necessarily damaging. The Negative State Relief Model states that human beings have an innate drive to reduce negative moods. People can reduce their negative moods by engaging in any mood-elevating behavior (called Mood repair strategies), such as helping behavior, as it is paired with positive value such as smiles and thank you. Thus negative mood increases helpfulness because helping others can reduce one's own bad feelings.

3.7 DECISION PROCESSING SYSTEMS

A decision support system (DSS) is an information system that aids a business in decision-making activities that require judgment, determination, and a sequence of actions. The information system assists the mid- and high-level management of an organization by analysing huge volumes of unstructured data and accumulating information that can help to solve problems and help in decision-making. A DSS is either human-powered, automated, or a combination of both.

Purpose of a Decision Support System

A decision support system produces detailed information reports by gathering and analysing data. Hence, a DSS is different from a normal operations application, whose goal is to collect data and not analyse it.

In an organization, a DSS is used by the planning departments – such as the operations department – which collects data and creates a report that can be used by managers for decision-making. Mainly, a DSS is used in sales projection, for inventory and operations-related data, and to present information to non-consumers in an easy-to-understand manner.

Theoretically, a DSS can be employed in various knowledge domains from an organization to forest management and the medical field. One of the main applications of a DSS in an organization is real-time reporting. It can be very helpful for organizations that take part in just-in-time (JIT) inventory management.

In a JIT inventory system, the organization requires real-time data of their inventory levels to place orders "just in time" to prevent delays in production and cause a negative domino effect. Therefore, a DSS is more tailored to the individual or organization that is making the decision rather than a traditional system.

Components of a Decision Support System

The three main components of a DSS framework are:

1. Model Management System

The model management system S=stores models that managers can use in their decision-making. The models are used in decision-making regarding the financial health of the organization and forecasting demand for a good or service.

2. User Interface

The user interface includes tools that help the end-user of a DSS to navigate through the system.

3. Knowledge Base

The knowledge base includes information from internal sources (information collected in a transaction process system) and external sources (newspapers and online databases).

Types of Decision Support Systems

- **Communication-driven:** Allows companies to support tasks that require more than one person to work on the task. It includes integrated tools such as Microsoft SharePoint Workspace and Google Docs.

- **Model-driven:** Allows access to and the management of financial, organizational, and statistical models. Data is collected, and parameters are determined using the information provided by users. The information is created into a decision-making model to analyse situations. An example of a model-driven DSS is Dicodess – an open-source model-driven DSS.

- **Knowledge-driven:** Provides factual and specialized solutions to situations by using stored facts, procedures, rules, or interactive decision-making structures like flowcharts.

- **Document-driven:** Manages unstructured information in different electronic formats.

- **Data-driven:** Helps companies to store and analyses internal and external data.

3.8 MOODS

3.8.1 Situational Impact on the Mood Onsets

Situational depression involves symptoms of depression that are related to stress. It is not a recognized clinical disorder but is an informal term used to describe what may be more formally diagnosed as a type of adjustment disorder.

These feelings of depression are usually triggered by a traumatic event, sudden stress, or major life change. Triggers can include events like a serious accident, divorce, job loss, or death of a loved one.

Situational depression may be diagnosed as adjustment disorder with depressed mood. While this condition is characterized by mood-related symptoms, the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) categorizes adjustment disorder as a type of trauma or stressor-related disorder.

Symptoms

Symptoms of situational depression include:

- Feelings of low mood and sadness
- Tearfulness; frequent bouts of crying
- Hopelessness
- Poor concentration
- Lack of motivation
- Loss of pleasure
- Withdrawing from normal activities
- Loneliness or social isolation
- Thoughts of suicide

After a difficult life event, whether it is a change in a relationship, the loss of your job, or the death of a loved one, the stress of the situation can cause you to feel sad, helpless, apathetic, lost, irritable, or even hopeless. You might cry frequently, feel listless and unable to focus, or find yourself unable to cope with normal, day-to-day tasks. Things you are normally able to handle seem overwhelming or impossible.

While symptoms usually recede within six months, they may range in severity from milder cases to more severe.

Causes

Situational depression begins after some sort of major life change or trauma. Some of the events that may trigger the onset of this form of depression include:

- Death of a loved one
- Divorce
- Relationship problems
- Relocating
- Job loss
- Financial problems
- Illness
- Unstable employment
- Unstable living situation
- Retirement
- Serious accidents
- Natural disasters
- Social issues at home, school, or work

There are certain factors that may increase the risk of situational depression. These include:

- Having an existing mental health condition
- Past childhood stress and trauma
- Experiencing multiple traumas or stressors at the same time
- A family history of depression

Situational depression differs from major depressive disorder (MDD) in a few important ways. Where situational depression is triggered by life stressors, MDD often has a range of causes. Situational depression is also shorter in duration, where MDD can be much longer-lasting. If a person has symptoms that meet full criteria for major depression in response to a stressor, they would not be considered to have "situational" depression or adjustment disorder but would be diagnosed with major depressive disorder.

Diagnosis

In order to be diagnosed with adjustment disorder with depressed mood, these symptoms must also cause marked distress and significant impairment in important areas of life functioning.

While situational depression tends to be less severe and not as pervasive as major depressive disorder, this does not make the condition any less "real." Situational depression challenges well-being and can make functioning in daily life difficult.

Treatment

Talking to your doctor can help determine whether you have situational depression. Fortunately, effective treatments can help you manage your symptoms. These often involve treating the symptoms as well as addressing the stressor that triggered these feelings.

Once the stressor has been dealt with, people will begin to adjust and cope as symptoms subside.

Situational depression can be a common and natural reaction to a very stressful or traumatic event. The symptoms are usually short-term and start to improve as:

- Time passes
- The individual recovers
- The situation improves

Treatments for situational depression may include individual counseling, group support, and medications to address serious symptoms of depression. In some cases, a combination of psychotherapy and medications may be used to treat situational depression.

Psychotherapy approaches may include the use of cognitive-behavioral therapy (CBT), which is an effective treatment for depression. CBT helps replace negative thinking patterns with more adaptive ones. It also helps people develop better resilience to stress and improves coping skills, making it helpful for preventing future relapses of depressive symptoms.

Medications to treat situational depression may include antidepressants and anti-anxiety drugs.

3.8.2 Weather and Seasonal Factors

You've heard the term Seasonal Affective Disorder. You also know that exposure to sunlight provides vitamin D, which affects hormone levels and, therefore, moods. You've sat inside on a gloomy, rainy day, annoyed that your plans were washed out. But how much does the weather really affect your mood?

Research has proven that warm temperatures and exposure to sunshine have the greatest positive impact on moods. A report published in the British Journal of Psychology found that warmer temperatures lowered anxiety and skepticism while more hours of sunshine increased positive thinking. The same study showed that high levels of humidity made it hard to concentrate, increasing fatigue and sleepiness.

Seasonal Affective Disorder

Seasonal Affective Disorder (SAD), the clinical name for winter depression or the winter blues, occurs due to the temperature drop and the short days during the winter months. Symptoms include depression and excessive eating and sleeping. Some people with SAD gain weight due to over-eating and inactivity. Women suffer from SAD up to three times more than men.

There are ways to treat SAD. Maintaining a regular schedule, especially sleep, is the most important factor. Exercise and exposure to natural light are also factors for keeping the winter blues at bay. Taking daily walks and sitting next to windows at home, work or in class can help. Putting your bedroom lights on a timer so that they come on before you wake up (like the sun rising) can help maintain a sleep schedule. In addition, there are special "warm" lights available for fighting seasonal depression.

The Weather and Allergies

Seasonal and year-long allergies can interrupt your sleep and daily routine, which greatly affects your mood. The weather also has a direct impact on allergies. Wind, rain, extreme temperatures, humidity, and air pollution can make allergies worse. Strong winds spread pollen and mold far and wide. High winds blow tree pollen in the spring and ragweed in the fall into the eyes, nose, ears and mouth of allergy sufferers, increasing exposure. A mild winter is great if you don't like cold weather, but it usually means early pollination for trees and flowers, and therefore, an earlier, heavier allergy season. Rain can help wash away allergens when trees and plants are pollinating, but rainy winters and autumns typically increase pollen counts in the following spring. High humidity levels create more growth in mold spores, thus causing more allergy symptoms. Cold temperatures, however, can provide great relief to allergy sufferers. During the spring, sudden drops in temperature can freeze tree pollen production. In the fall, ragweed season ends with the first frost.

There is relief for allergy suffers. Along with the myriad of over the counter and prescription medications, there are other remedies. Local, raw honey helps control allergies. Make sure you get honey that's local so the bees have used the same plants and grass you're having an allergic reaction to. Daily use of a neti pot for nasal irrigation also helps control allergies. Neti pots are available at most drug stores.

Research has shown that the weather does have an impact on how we feel. Whether its cold temperatures bringing on the winter blues or heavy winds blowing tree pollen around during the spring, the weather does play a part in your health and mood.

3.9 ANTICIPATING EMOTIONS

Anticipation is an emotion involving pleasure or anxiety in considering or awaiting an expected event.

Researcher considered anticipation as one of "the mature ways of dealing with real stress.... You reduce the stress of some difficult challenge by anticipating what it will be like and preparing for how you are going to deal with it". There is evidence that "the use of mature defences (sublimation, anticipation) tended to increase with age".

"Anticipation is the central ingredient in sexual desire." As "sex has a major cognitive component — the most important element for desire is positive anticipation". One name for pleasurable anticipation is excitement.

More broadly, anticipation is a central motivating force in everyday life —

"the normal process of imaginative anticipation of, or speculation about, the future". To enjoy one's life, "one needs a belief in Time as a promising medium to do things in; one needs to be able to suffer the pains and pleasures of anticipation and deferral".

There are several theories explaining anticipation in music. Two prominent theories are the Neurological theories of Chase that attribute expectation building and anticipation both to inherent Neurological pitch evolution (Darwinian selection as pitch/rhythm/harmony communication response expectation) and the related skillful use of chord sequences (holding V7 until expectations are met with E, A, B7, or the well-known Am/D7/G tease-satisfy sequence, with variations in the wheel of fifths).

A second well-accepted theory is Huron's "ITPRA" 5 module theories of expectation, where previous imaginative tension hits the event onset/horizon, with prediction and reaction oscillating (alternating) in the response system, and resulting in appraisal feedback.

From a global perspective, even given thousands of varying scale types worldwide, there is a universal human sense of satisfaction in the return to that scale's tonic (for example, C, in the major scale, key, and tonic of C major).

3.10 BEHAVIOUR BREEDS EMOTION, EMOTION BREEDS BEHAVIOUR, AND COGNITION ACTS AS MODERATOR

There was this serious and successful C.E.O. in Brazil who used to take the elevator two or three times in a row, in the early morning so that he could feel the atmosphere and culture of his company. And it wasn't unusual that the conversation started with some, in the lift, would informally continue in his office on the 20+ floor. Strangely enough, during his tenure, informal conversations, collaboration and pride to belong were flourishing. Roughly at the same period there was this Managing Partner whose assistant had agreed with his driver that he would warn her when they would be 5 minutes away from the office so that she could order the ushers to maintain an empty lift at the parking level so that the leader would not be disturbed in his reading of the Financial Times. The dominant culture was of isolation, internal competition and conditional collaboration.

When a courageous C.E.O. decides to share in front of 150 of his leaders what pushes his defence buttons and why, it instantaneously creates trust, respect and intimacy, better than any training or culture program could ever do. When another leader, nicknamed "Napoleon" by his troops, executes some of his key lieutenants at the opening of the yearly convention, it develops on the sport a culture of fear, isolation and internal competition.

Some psychologists say that "Behaviour Breeds Behaviour" … When I am positive and constructive, it should be no surprise that people around me will open up and respond accordingly. When I am impatient and negative, stress, criticism and aggressiveness will become the norm.

When we add the "Behaviour Breeds Behaviour" to the study of Hay (mentioned several times here) following which 70% of an organization's culture can be traced back to the behaviours of its leaders (us!) it may start to make sense that, other than strategy sessions, financial review, M&A targets, a very solid part of our job, as leaders is to be seen… behaving! I am always fascinated about of fast and distorted such or such leader's poor behaviour is being reported. If we do not occupy the behavioural terrain, by living and displaying behaviours which spectacularly and unequivocally demonstrate that we walk the talk of our messages, gossips and negative rumours will fill in the space.

Some philosophers claim that, when he spoke about Logos, Ethos and Pathos, Aristoteles was in fact providing the recipe of Charisma. Leaders of today need to occupy all three terrains:

- **Logos:** Being a thought leader or capable to elicit the best out of my people by encouraging them to speak-up, reflect, challenge orthodoxies.
- **Ethos:** My behaviours are a clear and unambiguous demonstration of my intentions and of the culture I want to develop in my organization.
- **Pathos:** I am accessible, showing empathy and able to ignite positive emotions in my people.

Emotions are distinct feelings or qualities of consciousness, such as joy or sadness, that reflect the personal significance of emotion-arousing events. The major types of emotions include fear, sadness, anger, surprise, excitement, guilt, shame, disgust, interest, and happiness. These emotions develop in an orderly sequence over the course of infancy and childhood.

Even during the first three or four months of life, infants display behavioral reactions suggestive of emotional states. These reactions are indicated by changes in facial expression, motor activity, and heart rate and of course by smiling and crying. Infants show a quieting of motor activity and a decrease in heart rate in response to an unexpected event, a combination that implies the emotion of surprise. A second behavioral profile, expressed by increased movement, closing of the eyes, an increase in heart rate, and crying, usually arises in response to hunger or discomfort and is a distress response to physical privation. A third set of reactions includes decreased muscle tone and closing of the eyes after feeding, which may be termed relaxation. A fourth pattern, characterized by increased movement of the arms and legs, smiling, and excited babbling, occurs in response to moderately familiar events or social interaction and may be termed excitement. In the period from 4 to 10 months, new emotional states appear. The crying and resistance infants display at the withdrawal of a favorite toy or at the interruption of an interesting activity can be termed anger. One-year-old infants are capable of displaying sadness in response to the prolonged absence of a parent.

Finally, infants begin displaying signs of the emotion of fear by their fourth to sixth month; a fearful response to novelty—i.e., to events that are moderately discrepant from the infant's knowledge—can be observed as early as four months. If an infant at that age hears a voice speaking sentences but there is no face present, he may show a fearful facial expression and begin to cry. By 7 to 10 months of age, an infant may cry when approached by an unfamiliar person, a phenomenon called stranger anxiety. A month or two later the infant may cry when his mother leaves him in an unfamiliar place; this phenomenon is called separation anxiety. It is no accident that both stranger and separation anxiety first appear about the time the child becomes able to recall past events. If an infant is unable to remember that his mother had been present after she leaves the room, he will experience no feeling of unfamiliarity when she is gone. However, if he is able to recall the mother's prior presence and cannot understand why she is no longer with him, that discrepancy can lead to anxiety. Thus, the appearance of stranger and separation anxiety are dependent on the improvement in memorial ability.

These emotions in young infants may not be identical to similar emotional states that occur in older children or adolescents, who experience complex cognitions in concert with emotion; these are missing in the young infant. The older child's anger, for example, can remain strong for a longer period of time because the child can think about the target of his anger. Thus, it may be an error to attribute to the young infant the same emotional states that one can assume are present in older children.

Chapter 4

DETECTING PROFITABLE MARKETS

4.1 INTRODUCTION

A market is a place where buyers and sellers can meet to facilitate the exchange or transaction of goods and services. Markets can be physical like a retail outlet, or virtual like an e-retailer. Other examples include the black market, auction markets, and financial markets. Markets establish the prices of goods and services that are determined by supply and demand.

The term market also takes on other forms. For instance, it may refer to the place where securities are traded—the securities market. Alternatively, the term may also be used to describe a collection of people who wish to buy a specific product or service such as the Brooklyn housing market or as broad as the global diamond market.

Technically speaking, a market is any place where two or more parties can meet to engage in an economic transaction—even those that don't involve legal tender. A market transaction may involve goods, services, information, currency, or any combination of these that pass from one party to another.

Markets may be represented by physical locations Where transactions are made. These include retail stores and other similar businesses that sell individual items to wholesale markets selling goods to other distributors. Or they may be virtual. Internet-based stores and auction sites such as Amazon and eBay are examples of markets where transactions can take place entirely online and the parties involved never connect physically.

Markets are arenas in which buyers and sellers can gather and interact. In general, only two parties are needed to make a trade, at minimum a third party is needed to introduce competition and bring balance to the market. As such, a market in a state of perfect competition, among other things, is necessarily characterized by a high number of active buyers and sellers.

The market establishes the prices for goods and other services. These rates are determined by supply and demand. Supply is created by the sellers, while demand is generated by buyers. Markets try to find some balance in price when supply and demand are themselves in balance. But that balance can in itself be disrupted by factors other than price including incomes, expectations, technology, the cost of production, and the number of buyers and sellers in the market.

Markets may emerge organically or as a means of enabling ownership rights over goods, services, and information. When on a national or other more specific regional level, markets may often be categorized as “developed” markets or “developing” markets, depending on many factors, including income levels and the nation or region’s openness to foreign trade.

4.2 WHAT MAKES A MARKET MORE ATTRACTIVE? THE SOUND SYSTEM CASE

Market attractiveness is used to describe the various possibilities of the profitability that any firm or organization can obtain a competitive market place. Now it is generally preferred to have a better market attractiveness, because the better the market attractiveness is, the more are the chances of obtaining potential profitability from that market by making investments in it.

Thus, a better market attractiveness means that it can attract more investors to make investments in one particular market because it has higher chances of giving back profitability. Thus, the market attractiveness is generally the measurement of the opportunities that a specific market promise.

Now, whenever a new startup is being launched, that is a new company is being started, the companies try to enter the new market after firth analyzing the market potential. This way they can determine whether the market is beneficial for them or not, whether it will be generating profit, what kind of seller and buyer relations persist.

Thus, in general, they try to find out whether the new market they will be entering in, will be beneficial to their company or not and what obstacles can the company face as they go ahead with that particular market. In this way, several factors can end up influencing the marketing and its potential to attract investors to make investments in them.

Now the market attractiveness is in general a concept which evaluates many different factors to determine whether a particular kind of market will be able to give back profit on investment or not.

It is a measure of the opportunities a market offers to an organization, with an acknowledgment of various factors within the market, including growth rate and market size, as well as outside factors such as access to raw materials, competition, and industry capacity.

Example of market attractiveness

Now since it depends on the fact that various factors would determine the extent of the market attractiveness one must consider these factors on a serious note. For example, the size of the market plays a significant role in increasing market attractiveness.

Other examples are the depth of the market; the numbers of potential non-consumers that are associated with a particular market are a few among many of the other factors that affect the market attractiveness to a much greater extent.

Now all of the factors mentioned above are used to determine the market attractiveness. The more is the market attractiveness; the more investors will want to invest in such a market. The most well-known example in which the market attractiveness was used is the McKinsey/General Electric Matrix, in which the companies were helped in assessing their products and their business portfolios according to the strength of the market.

The more the market is attractive, the more are the chances of generating profitability.

Now there are so many factors that can affect the market attractive and it depend on what factors are essential to the company and which elements are not. But still, there are a few factors that affect the market attractiveness which is common to all.

They can be market growth rate, current market margin, the market size at present, the number of competitors that are there in the market and various other factors which are specific to companies individually.

Now here are a few factors that can affect the market attractiveness and are common to all the companies-

1) The size of the market

The size of the market is an essential parameter to analyze the height of the market attractiveness. If the market is large, the producer will have more opportunities to sell the product in the market.

This will increase the potential of that particular market which in turn will increase the profitability of it. This means that the market will have a higher potential of the profit margin is at a lower value.

Also, if there is a particular market which is not growing, then this would mean that this specific market has got a constant amount of revenue or those they have limited revenue potential.

2) The growth rates

Now after the size of the market, the second important factor which can affect the market attractiveness is the growth rate. If there is a market that is not growing as expected, this would mean that its revenue potential is finite or constant.

If there is a market that has a low rate of growth, this means that this type of market is most probably a saturated one, if there are a lot of competitors who are fighting against each other in the same space and that too for the same sales.

This then may lead to a lower share in the market for all the competitors and thus will lead to lower profit margins.

3) Margins and pricing trends

Now since the revenues are determined by analyzing the volume and the margin, these two factors play an essential role when it comes to the determination of the profitability and the extent of the market attractiveness. Now suppose that there are two different markets but are having the same market size, and are having profit margins which are completely different from each other, in cases like these their different marginal points will be having the potential of being able to generate the different revenues.

Also if the pricing trends are different as well, then in cases like these, if the prices are decreasing, then it is highly likely that they might continue to do the same, thus eroding the profit margins. And if there is a case in the prices are increasing, then here they can be seen an increase in the revenue opportunity in that particular market.

4) Competitors

Now the completion in the market is an inevitable fact. One cannot expect to exist in a fair market where there is no competition. So it is necessary to have competition in a particular market, and it is equally important to understand who your real competitors are.

Now there are a few things that should be considered by the companies when they are trying to evaluate the competition in a particular market. They need to understand the strengths and the weakness of their competitors, the size of them, how aggressive are they towards the other competitors that they have.

Also, they must know what the several advantages that the competitors have over your company are, what is the number of the competitors in the market space that you are jumping in, and how much of the market share do they have already. Now a market is considered to be unattractive when there is a monopoly in it, which means that it is dominated by one single big company or organization.

This is also because that particular company that is ruling the market is likely to get aggressive towards a newly launched company and they may even try to dominate the various suppliers, contract and the distributors.

But if there is a market space which has many small companies competing against each is likely to be more attractive in terms of marketing.

5) Other additional factors

Now other than the factors mentioned above, there are also some other factors which may affect the market attractiveness. For example, if there is a company which is planning to expand their business overseas, they will have to assess the transportation infrastructure depending upon the geographical location, as these will play a key role in delivering their products.

Also, another critical aspect of the market attractiveness is that it should be highly flexible to any new kind of situation or challenges that may arise in the market.

4.2.1 Product Superiority

Product superiority can be defined as the differentiation in characteristics found between similar products that leads to one product being perceived to be of higher value and/or quality to the non-consumer both in consumer and industrial contexts.

4.2.2 Competitive Benchmarking

Competitive benchmarking is the process of comparing your company against a number of competitors using a set collection of metrics. This is used to measure the performance of a company and compare it to others over time.

This will often include looking at the practice behind these metrics as well. This means companies can look to define ‘best practice’ for specific metrics and compare this to their own approach. It also is an important step of a competitive analysis.

The benefits are clear.

Not only can you get an organized overview of your company and how it performs on different levels, you can also keep competitive. Benchmarking means you can easily spot when a competitor is doing well or beginning to struggle – both prime times to evaluate your own strategy.

Competitive benchmarking can fit around your business and its departments, being as broad or as granular as you like. There’s no set approach. It all comes down to do your aims and what areas are important to you.

With so much scope on what can be included, how do you even choose your competitive benchmarks?

You’re pre-existing KPIs are a good start of course, but this can be a chance to go a bit broader. Ask yourselves why you want to benchmark in the first place. Have a think about what metrics could be early indicators for bigger outcomes too.

For example, if your share of voice on social media drops and a competitor takes the top spot this means it’s time to investigate. Either something is going wrong on your end or they’re trying something new. You need to find out either way.

This shows how only tracking your performance against your past self can miss an important part of the picture.

You should also consult with all parts of the business to see what would be useful to include. This will ensure the benchmarking has value for as many people within the company as possible. Don't get hung up on sticking to top line metrics alone.

4.2.3 Consumers Barriers and Motivations

These four barriers are cynicism, skepticism, procrastination, and price. Each of these barriers is reasons non-consumers may not buy your product or service. It is important to know the psychology behind what helps non-consumers purchase to ensure you leave no room for non-consumers not to purchase.

Cynicism Barrier

People, who have the cynicism psychological barrier often ask themselves "Do I need this product/service?" This barrier is apparent when the person you're pitching to doesn't believe he or she has a problem to solve right away. If this type of consumer doesn't immediately get WHY they should care when they visit your website, read your blog, or see an ad, they will just click away from or skim over it. In order to get this type of consumer to care, you might have to work a little bit harder.

It is important to align your products and services with a problem or desire your prospects actually care about. One way to do this is by identifying your prospect's pain points. They will more likely give your business a chance when they see HOW what you sell satisfies their problems or wants. In order to gain a cynical consumer as a non-consumer, you must build trust. Establishing your business as an authority in your industry and sharing non-consumer reviews on your website are great ways to help build that trust with this type of consumer.

Skepticism Barrier

People, who have the skepticism psychological barrier often ask themselves "Does this product/service actually work?" There are two types of objections that skeptical consumers often face — feeling-driven objections and thought-driven objections. It is your job to make these prospects overcome these objections in order to have them go through your sales process. Feeling-driven objections are objections that come from emotions. Consumers that are skeptics say to themselves “It doesn’t feel right.” It is your job to take this objection and turn it around into an opportunity by showing them a solution. Thought-driven objections, for example, make the consumer say “It seems too risky.” It is important to validate their point of view and come up with a solution that reminds them that your business has a product or service that can address their problems or add significant value to them.

Trust is the biggest barrier for skeptic consumers. They might doubt your company’s expertise or track record. Skeptics already want what you’re selling, but they are not sure if they can trust you just yet. In order to do that, it is your responsibility as a business to show them why or how they can trust you. Offering proof that your product or service works and how they can get the results they want by buying is the key way to transform skeptics into non-consumers.

Procrastination Barrier

People who have the procrastination psychological barrier often ask themselves “I can always buy later… what’s the rush?” For whatever reason, they don’t see why purchase from your business has to happen right now, so they put it off. Scammer tactics such as stating there is only one more item left, for example, makes consumers feel too pressured and manipulated. If someone finds out these tactics are a lie, it could potentially ruin your business’s credibility. This may work for some companies; however, this is not the best way to make a procrastinator buy from you. A better way to make a procrastinator go through your sales funnel is by showing them how acting now is to their benefit. By giving these types of consumers an incentive when they buy your product or service now, they are likely to act faster than they would have without that incentive.

Price Barrier

People who have the price psychological barrier often tell themselves “It costs too much.” When it comes to pricing your product, it can be very difficult to feel confident in knowing what feels right in the eyes of your consumer (and versus your competition) and what they’ll be willing to pay. It can be even more difficult to know how an increase or decrease in price could affect your sales/profit. Consumers with these barriers are looking for a reason not to buy, therefore it is critical you show them the reasons they should buy a product or service from you. Showing them the value of what you offer and the return on investment they will get after purchasing from you is a great way to combat price barriers. Products and services frequently have customary prices in the minds of consumers. A customary price is one that non-consumers identify with particular items. If you do the math on how much your service or product actually costs and share that with your prospects, then they will likely drop the price objection and buy from you.

Consumer motivation is an internal state that drives people to identify and buy products or services that fulfil conscious and unconscious needs or desires. The fulfilment of those needs can then motivate them to make a repeat purchase or to find different goods and services to better fulfil those needs.

Motivational Levels

Depending on how important a purchase is to an individual, his motivational levels may vary from low to high. Influences include familiarity with the purchase, status factors and overall expense and value. Where fulfillment rewards are low, as with groceries, motivation levels are also relatively low and involve little decision-making behavior. Conversely, with a complex, risky and emotionally-charged process such as buying a new house, the drive to achieve the "right" result is high.

Motivational Behaviour

The behavioral aspect of consumer motivation concerns the actions someone takes before purchasing and consuming goods or services. A person might do a lot of research--evaluating alternatives, testing and sampling--before making a selection. She might decide to buy something based on which goods or services most closely meet and satisfy motivational wants and needs. Marketers aim to gain the most impact and eventual sales by linking their products and services to clearly defined consumer needs and by understanding what motivates people to buy.

Motivational Influences

Motivational levels differ greatly between individuals and are influenced by many external variables. These include the social value of making the "right" decision, beliefs about brands and alignment of brand values and personal values. If other people are involved in the decision, their motivation also affects the behavior of the primary consumer.

Accessing Motivation

Companies and marketers use a number of different tools to help them understand consumer motivation in relation to their products and services. This may help them orient their markets according to different buyer motivation. Marketers use pre-purchase and post-purchase focus groups, one-to-one interviews and online or postal surveys to develop their understanding of consumers' motivational drivers.

4.2.4 The Valley of Illusion

Our brains are wired to believe that light generally comes from above. This makes sense--here on Earth, light from the sun pretty much always is coming from either directly above us, or above us at an angle. This is such a persistent phenomenon that we use it to determine the shape of objects. If an object has a shadow beneath it, we assume it is convex, whereas if it has a shadow above it, we assume it is concave. This, as explained in this Minute Physics video, is why we struggle to discern whether a formation is a mountain or a valley when a photo is taken from far away, like space. Cartographers who make relief maps even orient their drawing's light in a place it would never naturally occur, just so we can understand what's sticking up and what's hollowed out. It's pretty nuts to consider how much of our perception is based on our very specific experiences living on this particular rock in space, and how different our experience would be otherwise.

4.3 Amplifying Consumers' Listening Experience

4.3.1 The Secrets of Sound Perception

The secret is frequency. The acoustic information that makes us hear Yanny is higher frequency than the acoustic information that makes us hear Laurel. Some of the variation may be due to the audio system playing the sound, Reicke says. But some of it is also the mechanics of your ears, and what you're expecting to hear.

Older adults tend to start losing their hearing at the higher frequency ranges, which could explain why Riecke could only hear Laurel, but his eight-year-old daughter could hear Yanny. It's a phenomenon you can mimic on a computer, he says: if you remove all the low frequencies, you hear Yanny. If you remove the high frequencies, you hear Laurel.

Most sounds — including L and Y, which are among the ones at issue here

— are made up of several frequencies at once. So, the problems with perception might have something to do with that. But Riecke suspects that this overlaps more in the real world than in the audio recording that's driving everyone up the wall. He thinks that the frequencies of the Y might have been made artificially higher, and the frequencies that make the L sound might have been dropped, Riecke says, although he notes this is speculation. Without knowing where this recording came from, he can't be sure.

So, if your sound card — or your ears — emphasize both the higher and the lower frequencies, you can toggle between the two sounds. And changing the sound mix to emphasize higher or lower frequencies might tip you toward Laurel or Yanny. That's what it took for Riecke — changing his headset wasn't enough.

We also called up Bharath Chandrasekaran, a professor in the department of communications sciences and disorders at the University of Texas at Austin. He told us that half his lab hears Yanny, and half his lab hears Laurel. But he also blames the file's noise for the confusion. "It's a little bit noisy, so that itself causes perception to be a little more ambiguous," he says. "Because it's noisy, your brain is filling in with what it thinks it should be."

4.3.2 Dutch Railways (NS), Music Soothes Waiting Travelers

The Dutch rail network primarily supports passenger transport. Rail travel comprises the majority of the distance travelled on Dutch public transport. The national rail infrastructure is managed and maintained by the government agency ProRail, and a number of operators have concessions to operate their trains. The entire network is standard gauge. The Netherlands is a member of the International Union of Railways (UIC), and its country code is 84.

Most Dutch trains are equipped with wifi. They offer no onboard catering, except for a limited service on some international trains.

Nederlandse Spoorwegen (NS) is a Dutch state-owned company, the principal passenger railway operator in the Netherlands. Founded in 1938, NS provides rail services on the Dutch main rail network. The Dutch rail network is the busiest in the European Union, and third busiest in the world after Switzerland and Japan.

The rail infrastructure is maintained by network manager ProRail, which was split off from NS in 2003. Freight services, formerly operated by NS Cargo, merged with DB Schenker in 2000. NS runs 4,800 scheduled domestic trains a day, serving 1.1 million passengers. Also, NS provides international rail services from the Netherlands to other European destinations and carries out concessions on some foreign rail markets through its subsidiary Abellio.

4.3.3 Music Preferences: Are You Pop or Classical?

The psychology of music preference is the study of the psychological factors behind peoples' different music preferences. Music is heard by people daily in many parts of the world, and affects people in various ways from emotion regulation to cognitive development, along with providing a means for self-expression. Music training has been shown to help improve intellectual development and ability, though no connection has been found as to how it affects emotion regulation. Numerous studies have been conducted to show that individual personality can have an effect on music preference, mostly using personality, though a recent meta-analysis has shown that personality in itself explains little variance in music preferences. These studies are not limited to American culture, as they have been conducted with significant results in countries all over the world, including Japan, Germany, and Spain, and Brazil.

One large-scale study conducted by researchers at Heriot-Watt University looked at more than 36,000 participants from all over the world. Participants were asked to rate more than 104 different musical styles in addition to offering information about aspects of their personalities.

According to the researcher, Adrian North, the reason people sometimes feel defensive about their taste in music might be related to how much it relates to attitudes and personality.

Pop Music

Fans of the top 40 pop hits tend to be extroverted, honest, and conventional. While pop music lovers are hardworking and have high self-esteem, researchers suggest that they tend to be less creative and more uneasy.

Classical Music

Classical music lovers are typically more introverted but are also at ease with themselves and the world around them. They are creative and have a good sense of self-esteem.

While “better” is a subjective term, classical music is overwhelmingly more complex, more varied, more precise and more nuanced than modern pop music.

Orchestras can easily contain 80+ musicians. Is one electric guitar and one bass guitar “better” than a ten-person string section? Maybe, but it’s certainly much less involved.

The average pop song is 4 min tops… and the majority of the time the song is edited/produced well after it is recorded. Overtures are among th shortest orchestral pieces and are typically 5–10 minutes. A single classical symphony, however, can stretch past 20 or even 30 minutes of play, and is nearly always performed live before an audience, therefore requiring a much greater degree of precision (a conductor!) as things can't be fixed afterward.

So, does all this make classical “better”?

In my opinion, not always. It does, however, make a great case for classical being a much “higher” form of the art of music.

4.3.4 Shazam Music: You Name It!

Shazam is an application that can identify music, movies, advertising, and television shows, based on a short sample played and using the microphone on the device. It was created by London-based Shazam Entertainment, and has been owned by Apple Inc. since 2018. The software is available for Android, macOS, iOS, Wear OS and watchOS.

The original developer of the app, Shazam Entertainment Limited, was founded in 1999 by Chris Barton, Philip Engelbrecht, Avery Wang, and Dhiraj Mukherjee. On September 24, 2018, the company was acquired by Apple for a reported $400 million

Shazam identifies songs based on an audio fingerprint based on a time-frequency graph called a spectrogram. It uses a smartphone or computer's built-in microphone to gather a brief sample of audio being played. Shazam stores a catalogue of audio fingerprints in a database. The user tags a song for 10 seconds and the application creates an audio fingerprint. Shazam works by analyzing the captured sound and seeking a match based on an acoustic fingerprint in a database of millions of songs. If it finds a match, it sends information such as the artist, song title, and album back to the user. Some implementations of Shazam incorporate relevant links to services such as iTunes, Apple Music, Spotify, YouTube, or Groove Music.

Shazam can identify music being played from any source, provided that the background noise level is not high enough to prevent an acoustic fingerprint being taken, and that the song is present in the software's database.

As well as the free app, the company has released a paid app called Shazam Encore. In September 2012, the service was expanded to enable TV users in the US to identify featured music, access cast information, and get links to show information online, as well as added social networking capabilities.

4.3.5 Amplifier Profiles: Business Applications

You've probably heard the term "op-amp" thrown around in electronics jargon, but what are these components? Operations amplifiers — op-amps for short, are integrated circuits, constructed mostly out of transistors and resistors. These integrated circuits multiply an input signal to a larger output. You can use these components with voltage and current in both DC and AC circuits.

Karl D. Swartzel Jr. invented the first op-amp in 1967, and he originally conceived them to do mathematical operations in analog computers — thus the "operation" part of their name. We now use op-amps in many other applications, and they form the basis of many modern analog electronic circuits.

What Does an Op-Amp Do?

At their most basic, an op-amp takes a differential signal — the voltage difference between the V+ and V- pins — and outputs a voltage proportional to this difference through the Vs+ and Vs- power supply. You can see the Vs+ and Vs- power supply in the image below. Many simplified representations of this component omit the Vs+ and Vs- nodes and only show the V+, V-, and Vout pins.

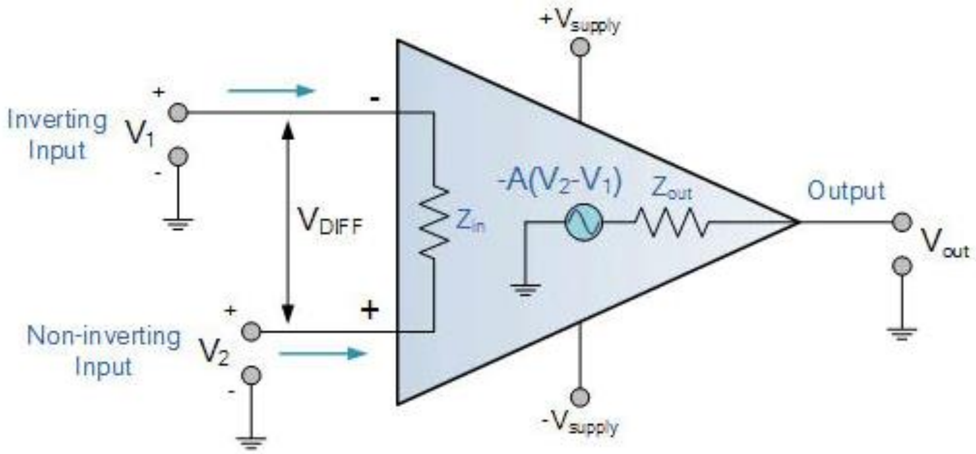


Figure 4.1: Op-Amp circuit diagram symbol

This open loop operation typically results in a device gain (known as the open loop gain or AOL) of 100,000 or more. Even a tiny difference in the voltage on the non-inverting (+) and inverting (-) pins works out to an output of nearly the supply voltage when the + input voltage is greater than the — input. This configuration acts as a comparator, turning a potentially varying input signal to a steady on/off output.

Closed-Loop Op-Amps

We usually use op-amps in a closed-loop configuration, with the output voltage feeding back (as feedback) into the inverting input to form a more controllable signal amplification. The simplest way to accomplish this is to use a buffer circuit, where the output feeds back into the inverting input with no resistors or other components.

To understand how this operation works, here are the two op-amp golden rules:

1. The output attempts to make the voltage difference between the inputs zero

2. The inputs draw no current

Here's how to construct a closed-loop op-amp:

1. Feed the input voltage into the + input

2. Connect the – to the amplifier's output

3. The output should go to the same value as the + input to keep both equal

This configuration can be useful for weak signals that require an amplified current before triggering another device.

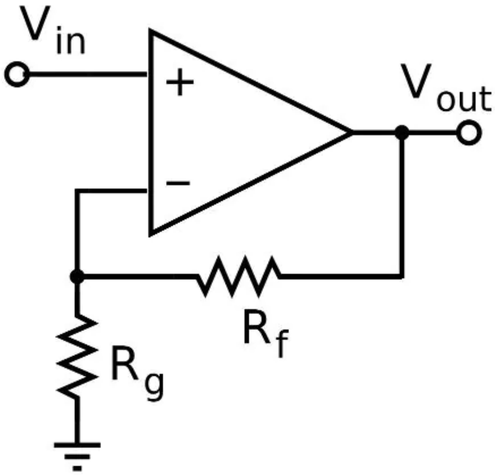


Figure 4.2: Op-amp with a feedback loop and voltage divider

In the image above, we took the closed-loop configuration concept further. If you want the output voltage to be a different value than the input, add a pair of resistors to form a voltage divider for the feedback loop. Amplification is thus based on the voltage we see at the node between these two resistors, calculated by the following formula:

Vin- = Vout * Rg / (Rg + Rf)

By this formula's logic, we can state the following:

Vout = Vin- * (Rg + Rf)/Rg

Vout = Vin- *(1 + Rf/Rg)

The 1 + Rf/Rg term is the closed-loop gain (ACL) of the circuit. If the resistors stay the same as Vin increases or decreases, Vout will vary proportionally by a factor of ACL up to the supply voltage.

Other configurations are also available, including feedback to the inverting pin, and using a voltage divider circuit to allow an op-amp to provide negative and positive voltage.

4.4 IMMUNE SYSTEM AND SENSORY PERCEPTION

To perform its functions, the immune system must ensure continuous reception and processing of information about the antigenic state of the organism. This perception must allow an evaluation of how serious is any divergence from the norm (the notion of "norm" of course varies during the development of the organism and between different organisms). The immune system initiates effector functions aimed to form an adequate defensive response. In the context of its "goals", the immune system can be considered as a sensory organ receiving and processing specific information. Although this concept has been formulated by others, it has not however contributed to a new understanding of the laws regulating the functions of the immune system functions, nor has the immune system been put on a par with other sensory systems More over the immune system has sometimes been declared an isolated and peculiar system and thereby been denied any analogy with neuronal networks altogether. In contrast to this firmly rooted view, we want to demonstrate some results of establishing common laws that regulate the functioning of the immune system as well as other sensory systems of the organism.

Sensory system structure and functioning

Despite all the differences between sensory systems, typically they perform their functions using a single set of principal mechanisms. Sensory systems allow for the continuous reception, processing and analysis of information sent by receptors after physical and chemical stimulation from the outer and inner environment of the organism. Evaluation of the full picture shows that sensory systems have an adequate response to the stimulus on the basis of the previous experience stored in their memory matrices. Generally, all sensory systems are characterized by pairs of opposite properties, such as high sensitivity and resistance to interference; sensitivity to a wide range of signals and fine discrimination between a variety of stimuli. These properties are essentially due to a specific structural organization of sensory system elements, which can be divided into the following levels:

- Sensory receptors;
- Information pathways;
- Neuronal networks to perceive and process sensory information.

Receptors transform the energy of the stimuli they have received into a sequence of frequency-modulated impulses suitable for their further transmission by the neuronal pathways. Such information is reported to display high resistance to interference. The relevant point is that the number of perceived characteristics of various stimuli exceeds considerably the actual number of specific receptors. This further implies that an accurate analysis of separate features of sensory stimuli cannot be based on the data from one receptor element. This also means that an increase in specificity could be accomplished through a cooperative activity of many elements of all sensory system levels.

Primary processing of information can take place already at the level of sensory receptors. Here, each sensory cell integrates the totality of received stimuli into a successive chain of events and displays an ability to adapt itself to the perceived impact.

An opportunity for finer processing begins during the passage of signals by transmission of information through pathways such as those represented by chains of neurons connected into a central nervous system The discriminatory relationships within this network allow transmitted information, from one receptor element, to be diverted to different neuronal pathways. Thus, a great number of elements can become involved in information processing. Converging in one neuron, these associations allow it to receive and integrate information from several sources. All receptor cells that have an impact on this neuron constitute its receptive field. Accordingly, any growth in the size of the receptive field raises receptor sensitivity to stimuli, although its localization is still not clear.

The existence of diverging and converging structural links can per se trigger a strong spread of the excited state. This implies that a weak sensory stimulus might be enough to trigger a chain reaction throughout the central nervous system. However, it does not usually happen due to lateral inhibition. The restriction of the spread of excitation, the presence of receptive fields around central neurons, and the organization of information transfer, are due to lateral inhibition, i.e. inhibitory interaction between neurons of one level. The intensity of lateral inhibition is directly proportional to the excitation degree of the sensory element and inversely proportional to the excitation distance between receptor elements, or neurons, present at various levels of the sensory system. Here, "distance" is meant the value used to describe the degree of comprehended information (for example geometric distance for visual images, frequency for audio images etc.). Projecting a visual image onto the receptive field, the receptor cells bordering on the line between light and dark undergo the following changes. When activated by illumination they suppress the activity of their neighbors. As a result, the shaded receptors next to the borderline become even more retarded than those amid unstimulated receptor cells. Accordingly, receptors within the illuminated area of the receptive field adjacent to the shaded receptors appear to be more activated than those in the heart of the illuminated area since the former at least partially avoid suppression by their neighbors. Thus, the sensory system, by using lateral inhibition, positively distorts images through their contrasts, i.e., accentuating their most dominant features and making image recognition and comparison significantly easier. Signal processing via lateral inhibition takes place throughout the entire transmission path and ends with information analysis in central organs (the cortex in higher animals).

Not only does the system respond to specific stimuli but also to the stimuli which are currently insignificant background and which must be inhibited. To form an adequate reaction toward novel environment and novel factors the organism has to start a special analysis of stimuli, compare them with the past experience and find appropriate behavioral responses. In other words, the organism has to be able to adjust itself for acceptance of new stimuli. When new "filters" are in place, the formation of a specific reaction is relatively straightforward and semi-automatic with the repetition of learned tasks. Fine analysis is a property of the cooperative work of a great number of nervous-system elements associated into a network. According to the widely popular concept of the probability organization of the brain nervous networks, the neuronal networks are functionally indeterminate dynamic structures which are assembled for a specific purpose and decompose as soon as this purpose is achieved. After disengagement, these very neurons can re-organize in new functional networks. Thus, the virtually unrestricted variety of brain activities is based on a relatively small number of neural cell types.

4.4.1 The Tenth Sense: The Sense of Danger

Have you ever wondered why animals avoid dangers by sensing some "signs" possibly related to the danger? A simple form of this phenomenon is called "fear conditioning", which is a type of learning commonly seen in every animal on the earth. By manipulating activity of specific neurons of the zebrafish brain, scientists at the National Institute of Genetics (NIG) in Japan have elucidated a neuronal population essential for fear conditioning in zebrafish. The study, published in the April 25 issue of BMC Biology, suggests that such a neural circuit essential for fear conditioning exists and is conserved during vertebrate evolution.

How can animals avoid dangers to survive? If animals experienced dangerous events together with some "signs", animals memorize the sign, became in fear of it, and perform fear responses, for instance an escape behavior. This is a type of learning, which is called "fear conditioning". In mammals including humans, the amygdala, one of the structures of the brain, plays an important role in fear conditioning. However, how the brain structure and neural circuits essential for fear conditioning have been conserved (or changed) during vertebrate evolution has not been known. Zebrafish, a popular model animal in biological studies, can perform fear conditioning as well as human and other mammals. Professor Kawakami's group has succeeded in developing technologies for visualizing and manipulating specific brain neurons in zebrafish by employing the yeast transcription factor Gal4, the green fluorescent protein (GFP), and the botulinum neurotoxin (BoTx). They have generated a collection of transgenic fish lines being used to study brain functions as well as other various organs by zebrafish researchers all over the world. Of the nearly 2,000 such transgenic fish lines in his lab, one played an important role in the current study that labels neurons in the dorsomedial (Dm) area of the telencephalon of zebrafish.

"In mammals including human and mouse, fear conditioning is mediated by a brain area called the amygdala. The amygdala integrates information about dangerous events, like electric shock, and some signs, such as visual or auditory stimuli. However, in fish, such neurons have not been found." Prof. Kawakami said.

"It is important to explore such neurons in fish because we can increase the knowledge about fundamental neural circuits for animals to perform evolutionary conserved fear conditioning"

For this purpose, Dr. Lal, a former graduate student in his lab, developed a behavioral analysis system. Fish are placed with a small tank with two compartments. Green LEDs are not harmful to fish. They gave electric shocks while green LEDs are on ten times a day for five consecutive days. Finally, when green LEDs are on, fish learned to escape from the compartment which was illuminated, and moved to another compartment.

"It is fun to see how smart they are" Dr. Lal said.

Using these technologies and resources, they have found that neurons in the region called Dm of the telencephalon of fish are essential for fear conditioning. Namely, these neurons are a functional equivalent of the amygdala of mammals. This result is a clue to clarify the structure and evolution of the neural circuit essential for fear conditioning.

Prof. Kawakami showed us his zebrafish facility where thousands of fish tanks can be seen, each of which contains genetically different fish that can turn on, or drive the GFP or BoTx expression in different types of neurons in the brain or in the body.

4.4.2 What is the Difference Between a Nerd?

Geek – An enthusiast of a particular topic or field. Geeks are collection oriented, gathering facts and mementos related to their subject of interest. They are obsessed with the newest, coolest, trendiest things that their subject has to offer.

Nerd – A studious intellectual, although again of a particular topic or field. Nerds are “achievement” oriented, and focus their efforts on acquiring knowledge and skill over trivia and memorabilia.

Both are dedicated to their subjects, and sometimes socially awkward. The distinction is that geeks are fans of their subjects, and nerds are practitioners of them. A computer geek might read Wired and tap the Silicon Valley rumor-mill for leads on the next hot-new-thing, while a computer nerd might read CLRS and keep an eye out for clever new ways of applying Dijkstra’s algorithm. Note that, while not synonyms, they are not necessarily distinct either: many geeks are also nerds (and vice versa).

4.4.3 Sensory Alert Codes and Product Design

Product design describes the process of imagining, creating, and iterating products that solve users’ problems or address specific needs in a given market.

The key to successful product design is an understanding of the end-user non-consumer, the person for whom the product is being created. Product designers attempt to solve real problems for real people by using both empathy and knowledge of their prospective non-consumers’ habits, behaviors, frustrations, needs, and wants.

4.5 SPOTTING BUSINESS OPPORTUNITIES

There are many ways to spot business opportunities. For example, by copying ideas used in your own field or those found in completely different areas. Or by absorbing more information through traveling, reading, and listening to people talking about their lives.

While business opportunities are mostly discovered and then exploited, they can also be created and then exploited. Opportunity creation involves much more uncertainty than opportunity discovery and requires visionary skills that allow for developing ideas people haven't even thought about.

The world is full of problems. One could say that (almost) everything is a problem. Or at least you can view it in that way.

Imagine the following situations.

You MUST wake up at 6:00am next morning and go to work. But how can you make sure you will wake up at 6:00am? You don't know when you are going to wake up, right? But you have to wake up so that you make it to work in time. If you don't wake up at 6:00am, you will be late from work, and that might get you embarrassed, or even fired.

After waking up you probably want to wash yourself. You might want to wash your body, hair, and teeth. If you don't wash them, you will smell bad and look like you are not taking care of yourself, which could lead to people trying to avoid you. You probably wouldn't feel comfortable either, so you wouldn't be very confident about yourself. But what do you need for washing, water? Something else? What else, where can you do it, and how?

Now you're hungry after the night and need to get something to eat before you go to work. If you don't have breakfast, you will start feeling low-energized, tired, maybe get a headache and an uncomfortable stomach pain.

Before you leave for work though, you might want to leave some of your belongings in the place where you slept. Otherwise, you would have to carry all your stuff on the streets and take it to work. But where can you leave it so that nobody will steal it from you? Where did you get all that stuff anyway? And where did you sleep?

You now need something to cover your body, because you don't want to be running around naked or catch a cold. It would also be great to have something for your feet to be able to walk faster without them hurting. And then you need to figure out how to get to work. You could walk but it's 5 miles…

During the rest of the day, you will have multiple other problems. You will have to eat again to keep yourself energized. You would like to know if your mom is fine as you know she was sick last time you visited her. On your way to the office, you have to open a locked door to get in. But actually, you don't like your job that much. You'd like to get a new one. Or maybe you don't want to work for anyone but become a company yourself.

These problems represent only a small fracture of all the problems we have every day. Seriously, there are so many more, but I'm sure you get the idea. Our lives are full of problems.

The above-mentioned problems are only quite basic human needs. A great way to understand human needs in general is to take a look at the graph below. Almost 80 years ago, Abraham Maslow presented the famous hierarchy of needs alongside his proposed theory of human motivation.

From problems to business opportunities

All problems are based on people's needs and wants. These needs and wants are the foundation of business opportunities.

Now, we know that our world is full of problems, and that these problems are based on people's needs. In order to move from "problem-thinking" to "opportunity-thinking", you have to consider two important factors.

First, what solutions are available? Most of our problems already have several solutions. But how good are the solutions? Could they be better? Do they miss crucial features? Do they have too many unnecessary features? Is the price reasonable? Could it be lower? Should it be lower? Can the solutions be easily reached? Are they customizable? If we look at opportunities based on the existence of problems and solutions, we can nicely place them in a two-by-two matrix.

Second, what do different groups of people want? People are different. So are their needs. The Chinese may not love potatoes, but the Germans do. Many guys don't wear pink, but many girls do. Most of us can't afford a Ferrari, but others can. Grouping people doesn't only help you spot the best opportunities but it also helps you focus on solving the exact problem of the chosen group of people and make them happy.

4.5.1 Consumers versus non-consumers

Given below in a tabular column are the difference between Non-consumer and Consumer.

Non-consumer	Consumer
Definition	
Non-consumer is the one who is purchasing the goods.	Consumer is the one who is the end user of any goods or services.
Ability to resell	
Non-consumer can purchase the good and is able to resell	Consumers are unable to resell any product or service.
Need for purchase	
non-consumers need to purchase a product or service in order to use it.	For a consumer purchasing a product or service is not essential.
Motive of buying	
The motive of buying is either for resale or for consumption	The motive of buying is only for consumption
Is payment necessary	
Must be paid by non-consumer	May or may not be paid by the consumer
Target group	
Individual or Company	Individual, family or group

4.5.2 Must Have versus Nice to Have

This method is easily understood by the customer and provides the project manager with a significant amount of latitude for negotiation later in the project, the importance of which cannot be underestimated.

So, the way it works is quite simple. After all of the requirements have been recorded, the list is re-visited with the customer to specify each requirement individually as must-have or nice-to-have.

- **Must-Have:** this is any requirement that absolutely has to be delivered for the project to be considered successful. This helps create the base set of expectations with the customer. These are sometimes also known as critical, base, or minimum requirements or a host of other names that indicate their status as absolutely required.
- **Nice-to-Have**: these are the complement of objectives or requirements that are considered desired or even important to the overall deliverable, but can be considered as optional or nice-to-have in the overall completion of the project. These may alternatively be classified as optional, non-critical or auxiliary requirements.

4.5.3 Substitution Products and Market Attractiveness

A substitute product is one that serves the same purpose as another product in the market. Getting more of one commodity allows a consumer to demand less of the other product.

The demand for substitute products shows a negative correlation. That is, consumption of one product reduces or replaces the need for the other. For example, if you are moving from point A to B, you can only use a car, bicycle, or another mode of transportation. However, the demand and pricing of substitute products exhibit a positive correlation. This means if the price of one product increases, the demand for the other increases.

For example, coffee can be said to be a substitute for tea, and solar energy is a substitute for electricity. If the price of coffee goes up, the demand for tea goes up, too, and vice versa. This will only apply if we assume that the price of tea remains constant. It is unlikely to see a person drinking coffee and tea at the same time. However, it is not hard to find an entity that uses both solar energy and electricity.

Impact of Substitute Products

1. A product with several substitutes is hard to price

Since every producer of the substitute product is trying to sell more, the only things they can rely on are branding and pricing. Thus, the prices of products with many substitutes are highly volatile. In a market where there are fewer substitute products, there is a higher probability of earning greater profits.

2. Customers are given a wide variety of products to choose from

The availability of more products can lead to a higher utility. No one single product can satisfy all consumers of a particular type. Therefore, the greater the number of substitutes, the higher the probability of every consumer getting what is right for them.

3. High competition

The greater the number of substitute products in the market, the more rivalry exists in the industry.

4. Low-quality products

In a bid to be the lowest seller in the market, companies try to use the least number of resources in their manufacturing process to reduce costs. However, this works against the welfare of the consumer, as it sometimes leads to the production of low-quality products.

Market Attractiveness

The term market attractiveness is used to refer to the various opportunities that are offered to any firm or any organization by the market, by acknowledging multiple factors that are present within the market itself.

These may include things like the market size, the growth rate of the market, outside factors affecting the market like access to the raw material, capacity of the industry and the competition.

Market attractiveness is used to describe the various possibilities of the profitability that any firm or organization can obtain a competitive market place. Now it is generally preferred to have a better market attractiveness, because the better the market attractiveness is, the more are the chances of obtaining potential profitability from that market by making investments in it.

Thus, a better market attractiveness means that it can attract more investors to make investments in one particular market because it has higher chances of giving back profitability. Thus, the market attractiveness is generally the measurement of the opportunities that a specific market promise.

Now, whenever a new startup is being launched, that is a new company is being started, the companies try to enter the new market after firth analyzing the market potential. This way they can determine whether the market is beneficial for them or not, whether it will be generating profit, what kind of seller and buyer relations persist.

Thus, in general, they try to find out whether the new market they will be entering in, will be beneficial to their company or not and what obstacles can the company face as they go ahead with that particular market. In this way, several factors can end up influencing the marketing and its potential to attract investors to make investments in them.

Now the market attractiveness is in general a concept which evaluates many different factors to determine whether a particular kind of market will be able to give back profit on investment or not.

It is a measure of the opportunities a market offers to an organization, with an acknowledgment of various factors within the market, including growth rate and market size, as well as outside factors such as access to raw materials, competition, and industry capacity.

4.5.4 Opportunity or Feasibility Study?

A feasibility study is an analysis that takes all of a project's relevant factors into account—including economic, technical, legal, and scheduling considerations—to ascertain the likelihood of completing the project successfully. Project managers use feasibility studies to discern the pros and cons of undertaking a project before they invest a lot of time and money into it.

Feasibility studies also can provide a company's management with crucial information that could prevent the company from entering carelessly into risky businesses.

A feasibility study is simply an assessment of the practicality of a proposed plan or project. As the name implies, these studies ask: Is this project feasible? Do we have the people, tools, technology, and resources necessary for this project to succeed? Will the project get us the return on investment (ROI) that we need and expect?

The goals of feasibility studies are as follows:

- To understand thoroughly all aspects of a project, concept, or plan
- To become aware of any potential problems that could occur while implementing the project
- To determine if, after considering all significant factors, the project is viable—that is, worth undertaking

Feasibility studies are important to business development. They can allow a business to address where and how it will operate. They can also identify potential obstacles that may impede its operations and recognize the amount of funding it will need to get the business up and running. Feasibility studies aim for marketing strategies that could help convince investors or banks that investing in a particular project or business is a wise choice.

Chapter 5

PREDICTING CONSUMERS' BEHAVIOUR

5.1 INTRODUCTION

Predicting consumer behaviour is a core responsibility for most marketers. Market research can help reveal consumer intentions, but penetrating the veil that protects actual consumer motivations from close scrutiny can be a tall order for even the best-designed research project. With the advent of big data, marketers are accessing increasingly more sophisticated predictive and analytic tools to forecast consumer behaviour. However, certain "old school" predictive techniques can be equally effective.

Big data are proving to be a valuable analytical resource thanks in part to retail transaction data from credit card purchases and from digital footprints, called "cookies," that users create as they browse the web. The power of big data is well illustrated in the often-cited story of Target and the pregnant teenager. As reported in "Forbes," the retailer apparently sent the teenager coupons for newborn gear, which was intercepted by the unknowing father. When her dad confronted the retailer, it was revealed that Target had been tracking the daughter's purchases and concluded she was pregnant based on the items she had bought there, which tracked closely with what other newly-pregnant women had purchased. While her father initially denied that was the case, he later confirmed that the information was correct and that he simply had not yet been told.

5.2 HOW WELL WILL A PRODUCT SELL? THE DETERGENT CASE

5.2.1 The Purchasing Intention Trap

Purchase intent is the probability that a consumer will buy a product or service. To evaluate purchase intent, marketers use predictive modeling to help identify the possibility of future outcomes based on historical data. Generally speaking, the modeling uses a core set of variables that includes factors like demographics, website engagement, past purchases, interaction with marketing messages and in B2B marketing, webcast or event attendance.

Evaluating purchase intent involves putting together data from different sources to understand which variables have the maximum impact. The knowledge is used to drive marketing strategies and also to refine messaging across different communication and marketing channels.

An important goal of assessing purchase intent is to gain insight into how effective an offline or online media campaign is and whether the money spent on marketing initiatives has an acceptable return on investment (ROI). The ultimate goal of analyzing purchase intent is to deliver the right message to the right audience at the right time.

Intent data analysis can also reveal when a customer has a strong predisposition to buy from a particular vendor, with practical applications ranging from prospect scoring and nurturing campaigns to programmatic advertising and account-based marketing (ABM). Used effectively, purchase intent can improve conversion rates, expedite deal velocity and create stronger synergies between marketing and sales.

5.2.2 A Tendency to Over perform

To perform better than the market as a whole for a stated period of time. To over perform does not necessarily mean to perform well. For example, if the market is expected to go down significantly, a stock may be said to over perform even if it dips slightly, provided it does not dip as far as the market as a whole.

5.2.3 Importance of the Sensory Context

The sensory system is the portion of the nervous system responsible for processing input from the environment. Beginning with detection through the transfer of stimuli to the central nervous system, the peripheral nerves and their associated receptors rapidly relay information. The peripheral nervous system consists of the somatosensory nervous system and autonomic nervous system. The sensory pathway of the somatosensory system involves spinal nerves which transmit information about the external environment to the spinal cord. The autonomic nervous system has visceral sensory neurons which are responsible for monitoring the internal environment and eliciting appropriate changes in effector organs to maintain homeostasis. This article will address both somatic and visceral sensory neurons with an emphasis on the clinical significance of somatic sensory neuropathy.

The anatomy of peripheral nerves consists of nerve fibers, supporting connective tissue, and blood supply. Sensory neurons are the afferent limb of somatosensory neural pathways. The neuron consists of a cell body, axon, and dendrites. Dendrites are finger-like projections that receive sensory input and transmit the signal through the axon to the cell body. Unipolar cell bodies of sensory neurons are located within sensory ganglia which may be in the dorsal root of the spinal cord or along cranial nerves. The receptive field of the neurons limits the ability of the sensory system to relay environmental information. An individual neuron's receptive field is the space in which a stimulus can modify the electrical activity of the neuron. There are different types of receptors for differing stimuli: thermoreceptors, mechanoreceptors, nociceptors, photoreceptors, and chemoreceptors. The receptors within a specific field react to stimuli by generating electrical activity along the associated first-order neuron in the form of an action potential.

Sensory nerves have different types of nerves fibers depending on their associated receptors. Classification of sensory nerves includes the numerical or Erlanger and Gasser system. Proprioceptors (position sensors) receive innervation via type Ia (A-alpha: muscle spindle), Ib (A-alpha: Golgi tendon organ), and II (A-beta: touch and pressure) sensory fibers. These fibers are large and myelinated with rapid conduction velocities. Mechanoreceptor innervation is by type II and III (A-delta: free nerve endings, cold) sensory fibers. Nociceptors (pain sensors) and thermoreceptor innervation by type III and IV (C: slow pain, heat) fibers. A-delta fibers are thinly myelinated and transmit information primarily related to acute pain to facilitate a withdrawal reflex upon synapse in the dorsal horn of the spinal cord. C fibers are smaller, unmyelinated fibers that require a higher threshold of stimulus than A-delta fibers. These are responsible for the slower onset of deeper pain after an initial insult relayed by the faster A-delta fibers.

To summarize, in order of decreasing diameter and velocity:

- Proprioceptors: A-alpha, A-beta
- Mechanoreceptors: A-beta, A-delta
- Nociceptors and thermoreceptors: A-delta, C-fiber

The supportive structures of the nerve fibers include the mesoneurium, epineurium, perineurium, endoneurium, and myelin sheath. The mesoneurium is the connective tissue sheath that suspends the nerve trunk within the soft tissue and is continuous with the underlying epineurium.

The epineural sheath contains the extrinsic blood vessels, and further internal plexuses lie in the epineurium, perineurium, and endoneurium. The interfascicular epineurium is loose connective tissue composed of longitudinal collagen fibers that protect the nerve trunk against mechanical stress. The perineurium is the connective tissue layer covering individual fascicles or bundles of axons. The endoneurium is the fibrous tissue directly covering individual axons. Individual axons are insulated by myelin (except for C fibers) which is produced by Schwann cells in the peripheral nervous system.

Visceral sensory nerves transmit pain, stretch, temperature, and chemical change in visceral organs which gets interpreted as sensations like nausea, hunger, gas, cramping, etc. General visceral afferent fibers are considered part of the autonomic nervous system, but unlike the efferent arm, GVA fibers do not classify as sympathetic or parasympathetic. GVA run with general somatic afferent (GSA) fibers in the gray matter of the dorsal horn and can cause referred pain. Referred pain takes place in the dermatome of the corresponding spinal segment of the signal-producing internal organ. For example, myocardial ischemia can refer to the left shoulder; this is due to misinterpretation of the visceral signal as a somatic pain signal by the cortex since the fibers run together centrally. Cranial nerves with GVA fibers include the glossopharyngeal nerve and vagus nerve and explains "brain freezes" as thermoreceptors of the palate sense something very cold causing reflexive vasoconstriction mediated by cranial nerves IX and X resulting in engorged sinus capillaries causing a headache.

5.3 PASSING CONSUMERS' SMELL TEST

5.3.1 The Secrets of Smell Perception

Perceiving smell begins with olfactory receptors in the nose and ends in the brain. Each smell activates a specific combination of olfactory neurons, which the brain decodes as a particular aroma. This "combinatorial" coding allows us to detect many more smells than we have specific receptors. Each chemical odorant triggers its own unique pattern of neural activity, leading to our perception of a particular smell.

The moment we catch a whiff of garlic sizzling in a pan, olfactory neurons in our noses spring into action sending electrical signals on a journey through our brains. The first stop is the olfactory centers where they transform into what we perceive as smell. As the signals travel to deeper regions of the brain, they can trigger emotion and memories as they arrive in the amygdala and hippocampus.

Although one could survive in the modern world without a sense of smell, losing it can signal something more pernicious in the brain. Patients with some neurodegenerative disorders including Alzheimer's disease and Parkinson's disease frequently struggle to detect and identify smells. These problems crop up long before their memories become impaired or they develop tremors. Studies indicate deficits in smell amongst healthy older adults can predict later cognitive decline or Parkinson's disease.

Researchers continue to explore why this happens in order to develop early diagnostics and potentially new therapies aimed at the underlying cause of the damage.

Although the vast majority of olfactory receptors exist only in the nose, scientists have found some receptors in other tissues including the lungs, kidneys, skin, heart, muscle, colon, and brain. As a result, scientists are beginning to posit that they serve not just as smell receptors but as more general chemical sensors. Sperm, for example, use input from olfactory receptors to navigate to unfertilized eggs. In kidneys, they help mice regulate blood pressure. Lungs use olfactory receptors to detect noxious chemicals and constrict airways.

Researchers have also begun exploring how olfactory receptors throughout the body may possibly facilitate the effects of certain drugs.

5.3.2 Sofitel Amsterdam the Grand Carousel of Senses

Located between the two oldest canals in the heart of the city, Sofitel Legend the Grand Amsterdam has a proud and rich history. Furnished with French elegance and grandeur, the hotel blends sleek design with five-star facilities, including 52 luxury suites with Butler Service and an indulgent spa.

As well as housing fantastic hotel rooms and suites, there's the fine-dining restaurant Bridges, garden bistro Oriole which serves Mediterranean dishes, a traditional Dutch brown café and Library 'Or' where you can enjoy a delicious Afternoon Tea. This makes The Grand the perfect stop for the discerning business traveler or for a luxury stay in Amsterdam.

The history of this luxury hotel is deeply entwined with the past of the city – from a 15th-century convent to royal lodgings to Dutch Admiralty headquarters to the city hall of Amsterdam. Now, after a careful renovation by French designer Sybille de Margerie, it is a place of hospitality, art and culture. Bold colors set off creamy marble; contemporary lights glimmer on graceful arches and stained glass; rosewood handrails sweep up to luxurious suites and rooms. Its magnificent banqueting facilities include the Council Chamber where the Netherlands' former queen, Princess Beatrix, married in 1966.

All 179 rooms have a legendary Sofitel MyBed and a modern bathroom with walk-in shower. Dressing gowns and slippers are provided for extra comfort. Free Wi-Fi is available in the entire hotel, while extra flourishes, such as poetry and fragments of the rich history, captivate and seduce anyone who visits the hotel.

5.3.3 A Popular Scent: Häagen Dazs Vanilla Ice-Cream

Some things are so good in their simplest forms that there's no need to insert to them. The Haagen-Dazs vanilla flavor is one of them. It is scrumptious and gracefully simple. It is prepared with only 5 ingredients to give you the most extremely rich and comfortable ice cream. This ideal marriage of pure, sweet cream and exclusively imported vanilla creates a sugary scent of exotic spice and a characteristic taste that lingers on your tongue.

5.3.4 Predicting Scents Preferences

Pleasant and unpleasant odours are a part of everyone's life, but how do our reactions to smells change when other odours are present? To answer this question, researchers at the RIKEN Brain Science Institute in Japan have combined experimental and modelling approaches to reveal the process through which smell preference is computed in the brain. Published in Neuron, the work shows how the activity of neurons in the olfactory processing centre of the Drosophila brain can be decoded to predict behavioral responses to odours, and reveals that the relative preference of odours can flip depending on the situation.

For many animals, the sense of smell--the ability to detect and interpret chemicals in the environment--is fundamental to survival. From insects to mammals, olfaction is central to a range of behaviors, including foraging, habitat and prey location, predator avoidance, and social communication. While responding appropriately to odors requires the ability to distinguish those that are harmful from those that are beneficial, how this is achieved in the brain is an open question.

When an odor is smelled, it activates a population of small neuronal structures called glomeruli in the first olfactory center of the brain. While odor information is generally recognized to be encoded as patterns of glomerular activity across space and time, the sheer number of glomeruli--about 1,800 in mice and 5,500 in humans--is a major impediment to olfactory research.

To overcome this obstacle, Hokto Kazama and his team took advantage of the simpler olfactory system in the fruit fly Drosophila melanogaster, which is similar in function and organization to that of mammals, but contains only about 50 glomeruli. Explains Kazama, "Because of the limited number of glomeruli, we were able to use two-photon calcium imaging technology to systematically record odor-evoked activity from almost all fly glomeruli in response to a large number of odorants."

Fly behavior was monitored in a clever flight-simulator arena. In this virtual reality system, the fly's head is fixed and surrounded by an olfactory and visual landscape that is rotated in real-time in response to wing movements. The flies displayed a continuum of responses ranging from strong attraction to strong aversion--virtually flying into or away from the odor--and their judgments were made extremely quickly, sometimes in as short as 200 milliseconds.

By analyzing these behavioral and physiological data, researchers formulated a mathematical model that explains how attraction and repulsion to odorants can be computed from the activity of olfactory glomeruli. Their model suggests that each glomerulus contributes to attraction or aversion with a specific weight. Summing the transformed and weighted activity of all glomeruli not only matched the real behavioral responses to the odors used to make the model, but also accurately predicted responses to new odorants. Kazama notes that contrary to the prevalent hypothesis in the field, the results imply that this computation does not rely on a small subset of glomeruli, but likely requires most, if not all, of them.

The model also predicted that the relative preference of odors would vary, and could even switch, depending on the nature of other odorants present in the environment. The team performed a series of experiments in which the same odors were presented under different conditions, and successfully verified this prediction. Adds Kazama, "Not only does this demonstrate that even flies have the ability to adapt to their olfactory environment, it exemplifies the usefulness of our approach that combines physiological measurements with mathematical modeling of behavior and neural activity."

Because the basic function and wiring of the olfactory system are well conserved from flies to humans, the study is expected to provide a deeper understanding of the principles and mechanisms of olfactory processing in the human brain.

5.4 MALE, FEMALE, AND CHICKEN

5.4.1 Genetics and Hormones

Genetics is a branch of biology concerned with the study of genes, genetic variation, and heredity in organisms.

Though heredity had been observed for millennia, Gregor Mendel, Moravian scientist and Augustinian friar working in the 19th century in Brno, was the first to study genetics scientifically. Mendel studied "trait inheritance", patterns in the way traits are handed down from parents to offspring. He observed that organisms (pea plants) inherit traits by way of discrete "units of inheritance". This term, still used today, is a somewhat ambiguous definition of what is referred to as a gene.

Trait inheritance and molecular inheritance mechanisms of genes are still primary principles of genetics in the 21st century, but modern genetics has expanded beyond inheritance to studying the function and behavior of genes. Gene structure and function, variation, and distribution are studied within the context of the cell, the organism (e.g., dominance), and within the context of a population. Genetics has given rise to a number of subfields, including molecular genetics, epigenetics and population genetics. Organisms studied within the broad field span the domains of life (archaea, bacteria, and eukarya).

Genetic processes work in combination with an organism's environment and experiences to influence development and behavior, often referred to as nature versus nurture. The intracellular or extracellular environment of a living cell or organism may switch gene transcription on or off. A classic example is two seeds of genetically identical corn, one placed in a temperate climate and one in an arid climate (lacking sufficient waterfall or rain). While the average height of the two corn stalks may be genetically determined to be equal, the one in the arid climate only grows to half the height of the one in the temperate climate due to lack of water and nutrients in its environment.

Hormones are chemical messengers that are secreted directly into the blood, which carries them to organs and tissues of the body to exert their functions. There are many types of hormones that act on different aspects of bodily functions and processes. Some of these include:

- Development and growth
- Metabolism of food items
- Sexual function and reproductive growth and health
- Cognitive function and mood
- Maintenance of body temperature and thirst
- Hormone disorders are diagnosed in the laboratory as well as by clinical appearance and features. Laboratory tests can be used to test bodily fluids such as the blood, urine or saliva for hormone abnormalities.
- In the case of hormone deficiency, a synthetic hormone replacement therapy may be used and in cases of excess hormone production, medications may be used to curb the effects of the hormone. For example, a person with an underactive thyroid gland or hypothyroidism may be treated with synthetic thyroxine which can be taken in the form of a pill, while a person with an overactive thyroid may be administered a drug such as propranolol to counteract the effects of the excess thyroid hormone.

5.4.2 Women are from Venus and Men from mars

Men Are from Mars, Women Are from Venus (1992) is a book written by American author and relationship counselor John Gray, after he had earned degrees in meditation and taken a correspondence course in psychology. The book states that most common relationship problems between men and women are a result of fundamental psychological differences between the sexes, which the author exemplifies by means of its eponymous metaphor: that men and women are from distinct planets—men from Mars and women from Venus—and that each sex is acclimated to its own planet's society and customs, but not to those of the other. One example is men's complaint that if they offer solutions to problems that women bring up in conversation, the women are not necessarily interested in solving those problems, but mainly want to talk about them. The book asserts each sex can be understood in terms of distinct ways they respond to stress and stressful situations.

The book has sold more than 15 million copies and, according to a CNN report, it was the "highest ranked work of non-fiction" of the 1990s, spending 121 weeks on the bestseller list. The book and its central metaphor have become a part of popular culture and the foundation for the author's subsequent books, recordings, seminars, theme vacations, one-man Broadway show, TV sitcom, workout videos, a podcast, men's and ladies' apparel lines, fragrances, travel guides and his-and-hers salad dressings.

Gray writes how men and women each monitor the amount of give and take in relationships. If the balance shifts, one person feeling they have given more than they have received, resentment can develop. This is a time when only communication can help to bring the relationship back into balance.

Gray further asserts men and women view giving and receiving love differently, how individual actions intended as loving expressions are "tallied up." According to Gray, women and men are often surprised to find their partners "keep score" at all, or that their scoring methods widely differ.

He says women use a points system which few men are aware of. Each individual act of love gets one point, regardless of magnitude. Men, on the other hand, assign small acts, small expenditures, fewer points. Larger blocks of points (20, 30, 40 points, etc.) go to what they consider bigger expenditures. To a woman, the emotional stroke delivered by sincere attention is inseparable from the act. The different perception of expenditure can lead to conflict when the man thinks his work has earned him, say, 20 points and deserves corresponding recognition, while the woman has assigned him only 1 point and recognizes him accordingly. The man tends to think he can do one Big Thing for her (scoring 50 points) and not do much else, assuming he has "banked" points and can afford to "coast." The woman should be satisfied with his performance and give him credit for it. Instead, the woman would rather have many little things done for her on a regular basis, because women like to think their men are thinking of them and care for them more constantly. Gray clarifies how these two perceptions of "strokes" cause conflict. He encourages talking about these issues openly.

Another major idea put forth in Gray's book regards the difference in the way the genders react to stress. Gray states when male tolerance to stressful situations is exceeded, they withdraw temporarily, "retreating into their cave", so to speak. Often, they literally retreat: for example, to the garage, or to go spend time with friends. In their "caves", men (writes Gray) are not necessarily focused on the problem at hand. Yet this "time-out" lets them distance themselves from the problem and relax, allowing them to re-examine the problem later from a fresh perspective.

Gray holds that male retreat into the cave has historically been hard for women to understand. When women become unduly stressed, their natural reaction is to talk with someone close about it (even if talking doesn't provide a solution to the problem at hand). This sets up a natural dynamic where the man retreats as the woman tries to get closer, which becomes a major source of conflict between them.

The "wave" is a term Gray uses to describe a natural dynamic centered around a woman's ability to give to other people. He writes when she feels full of love and energy to give to others, her wave is stable. When she gives of herself, but doesn't receive adequate love and attention in return, her wave becomes unbalanced, cresting and eventually crashing. Then, a woman needs the attention, listening, understanding, and reassurance of those around her—as well as self-love. Gray explains that once she is rejuvenated by getting the support she needs, her wave is able to build and rise once again, with renewed love and energy to give. Men, advises Gray, should support this natural cycle by not being threatened by it or telling her why she should not feel the way a woman feels.

5.4.3 Innate Versus Acquired

The immune system is typically divided into two categories--innate and adaptive--although these distinctions are not mutually exclusive.

Innate immunity

Innate immunity refers to nonspecific defense mechanisms that come into play immediately or within hours of an antigen's appearance in the body. These mechanisms include physical barriers such as skin, chemicals in the blood, and immune system cells that attack foreign cells in the body. The innate immune response is activated by chemical properties of the antigen.

Adaptive immunity

Adaptive immunity refers to antigen-specific immune response. The adaptive immune response is more complex than the innate. The antigen first must be processed and recognized. Once an antigen has been recognized, the adaptive immune system creates an army of immune cells specifically designed to attack that antigen. Adaptive immunity also includes a "memory" that makes future responses against a specific antigen more efficient.

5.4.4 Toy Story

Toy Story is a 1995 American computer-animated comedy film produced by Pixar Animation Studios and released by Walt Disney Pictures. The first installment in the Toy Story franchise, it was the first entirely computer-animated feature film, as well as the first feature film from Pixar. The film was directed by John Lasseter (in his feature directorial debut), and written by Joss Whedon, Andrew Stanton, Joel Cohen, and Alec Sokolow from a story by Lasseter, Stanton, Pete Docter, and Joe Ranft. The film features music by Randy Newman, was produced by Bonnie Arnold and Ralph Guggenheim, and was executive-produced by Steve Jobs and Edwin Catmull. The film features the voices of Tom Hanks, Tim Allen, Don Rickles, Wallace Shawn, John Ratzenberger, Jim Varney, Annie Potts, R. Lee Ermey, John Morris, Laurie Metcalf, and Erik von Detten. Taking place in a world where anthropomorphic toys come to life when humans are not present, the plot focuses on the relationship between an old-fashioned pull-string cowboy doll named Woody and an astronaut action figure, Buzz Lightyear, as they evolve from rivals competing for the affections of their owner, Andy Davis, to friends who work together to be reunited with Andy after being separated from him.

Following the success of their 1988 short film Tin Toy, Pixar was approached by Disney to produce a computer-animated feature film told from a small toy's perspective. Lasseter, Stanton, and Docter wrote early story treatments, which were rejected by Disney, who wanted the film's tone to be "edgier". After several disastrous story reels, production was halted and the script was rewritten to better reflect the tone and theme Pixar desired: "toys deeply want children to play with them, and ... this desire drives their hopes, fears, and actions". The studio, then consisting of a relatively small number of employees, produced the film under only minor financial constraints.

Toy Story premiered at the El Capitan Theatre in Los Angeles, California, on November 19, 1995, and was released in theaters in North America on November 22, 1995. It was the highest-grossing film during its opening weekend,[2] eventually grossing over $373 million worldwide. The film received critical acclaim, and holds a rare 100% approval rating on Rotten Tomatoes. It was praised for the technical innovation of the 3D animation, wit and thematic sophistication of the screenplay, musical score, and vocal performances (particularly Hanks and Allen); it is considered by many to be one of the best animated films ever made. The film received three Academy Award nominations (Best Original Screenplay (the first animated film to be nominated for this award), Best Original Song for "You've Got a Friend in Me", and Best Original Score) as well as winning a Special Achievement Academy Award In 2005, the United States Library of Congress selected the film for preservation in the National Film Registry for being "culturally, historically, or aesthetically significant".

5.5 TARGETING CONSUMERS WITH THE HORMONAL QUOTIENT TM (HQ)

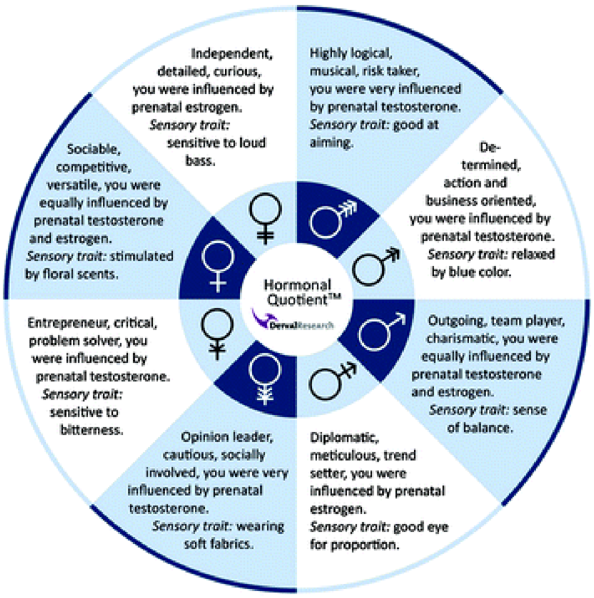


Figure 5.1: Hormonal Quotient TM (HQ)

5.5.1 Limits of the 'One-Size-Fits-All' Approach

Basic purpose of research is to provide a new insight into what is already known. Hence everybody should and is being (rightly) promoted to provide one's own point-of-vision in patient care. And collectively this knowledge is supposed to lead us to a brave-new-world where management of illnesses is simple, affordable and human suffering is reduced.

But fixing a quota for research poses new challenges and raises new questions. Last year Dr. Rakesh Aggarwal, Professor at SGPGIMS Lucknow, penned an editorial on this issue and that was published simultaneously in almost all the journals of repute. BMJ too covered the theme. Several points raised by Prof. Dhastagir Sheriff on this webpage are already covered in that editorial. What we want to highlight is that sometimes it becomes difficult even for top scientists/artists/thinkers to convince the world about their views, and judging that too demands another level of understanding. If everything is pulped to a single lump, there may (rightly) be question-marks about our intellect.

Charles Darwin, proponent of famous Theory-of-Evolution by Natural Selection, made his observations while he was on a voyage in a ship. His theory provides us one-of-the-most fundamental insights into animal (including human) biology. Now MCI wants everybody to be trialists. If Darwin were to present his great theory to present day MCI inspectors, they may place the great observer at the end of the promotion-list, as he simply did not conduct a trial. Observational studies, as per our understanding, are uncommonly published as original articles, and original article are the trump cards to get promotions as per existing (funny and impugned) rules.

Ignaz Semmelweis, a physician, more than 150 years ago made an observation that puerperal-fever is common among mothers whose delivery is conducted by doctors, as compared to those made by midwives. Based on the observation he promoted hand washing technique. This is still one-of-the-most fundamental principles of safe motherhood. If Semmelweis were to present his observation in front of MCI inspectors today, they would gently tap him on the knuckles, and perhaps advise the astute observer to conduct some trial, if he wishes to get promotion.

Werner Forssmann, a daring doc, inserted a wire into his own heart and then got himself X Rayed. This was for the first time in known human history in a living body. The wire was found inside his heart and the finding challenged the then prevalent theories. After getting to know about the experiment, senior professors banned his entry to the lab, yet the discovery put the foundations for current day cardiac catheterization and interventional cardiology. Later on Forssmann was awarded the Nobel Prize for the discovery in 1956. If he were to present his experiment to present day MCI inspectors, after that groundbreaking X Ray, he will simply be asked to do what everybody is doing - a worthless clinical trial or two, and then get promotion.

When Galileo Galilei directed his telescope towards Jupiter and saw its moons and then shook the very foundation of the then dogma, he was not conducting some sophisticated scientific trial. Religious bodies then used to preach that this world was Earth-centric and everything revolved around the Earth. When Galileo saw moons revolving Jupiter, he put that theory upside down. No credit was given to him in his lifetime, he was jailed and lost his eyesight there. Alas, if he were to present his observation to present day MCI inspectors, they again will label that observation as a mere ordinary case report, and he will not be promoted. We shudder to think that how many such fundamental observations have been relegated to a corner, and how many times such honest medical observers have been asked to do something useful as per standards of our MCI inspectors.

LIGO experiment is being conducted to listen to gravitational waves (tweets) of collision of distant stars. As per some accounts, this is the biggest endeavor in scale and scope of mankind date to unravel the mysteries of the universe, which all of us share. If MCI were to assess the data generated in the mammoth tunnels, quickly they will provide credit to the first 2 researchers, as that is the existing rule. As per existing promotion rules of MCI, only the first 2 researchers get the credit howsoever large or small the study is. Therefore, LIGO researchers, to some extents are fortunate that they are not under the direct scrutiny of MCI. If that were the case, instead of putting their brains to analyses the data and interpreting its results, and then designing even a better experiment, the researchers would have been reduced to squabbling about deciding the first 2 authors. This is the way we in India treat the hardworking scientist, whose work has the potential to change the future of all of us.

Nowhere we intend to belittle the importance of clinical trials, or the significance of the data generated by that tedious process. What we want to point out by citing these geniuses and those historical moments which changed the history, is that that is not the only way that science progresses. There is an urgent need to relook and revisit existing MCI rules. Yesterday while throwing open its new National Museum, President Barack Obama says that America is a constant work-in-progress. We believe that same principle of work-in-progress is also true for another circumstances -- aligning promotion rules for existing evidences and realities in India too. If in the name of conducting and promoting clinical trials, creativity is suppressed, free opinion is bulldozed and original ideas are scorned; all of us will gradually drift towards a world where all the top positions in all the top academic universities will be occupied by duplicates.

5.5.2 Sensors and Segmentation

Companies that are looking to partner with specialists to take advantage of these tools should manage those engagements carefully. To ensure quality input from neuromarketing consultants, Karmarkar recommends hiring in-house neuroscientists to oversee the work.

Traditionally, marketers are concerned with more than simply measuring consumer preferences; they also try to change them. Neuroscience researchers are beginning to probe whether the brain can be used to influence purchases—an area of study that generates excitement and also ethical concerns. Here are some ways neuroscience might be used in the future to influence consumer behavior:

- Better segmentation. Marketers want to know which portions of a population are most open to their advertising and branding efforts. This segmentation is traditionally performed according to demographics (age and wealth, for example) or psychographics (impulsivity). It may be more fruitful to segment consumers by brain differences: A study by neuroscientists at INSEAD found differences in the brains of people who are easily influenced by marketing cues.

- Sleep nudging. Neuroscientists have learned that we are susceptible to influence during windows in our sleep. A 2015 study found that exposing smokers to the smell of cigarettes mixed with rotten eggs during "phase 2" (when the body prepares for deep sleep) led to a reduction in smoking for several days. Since then similar work has shown the ability to increase preference for certain products or promote certain behaviors.

- Hormone manipulation. Brain activity is influenced by neuromodulators—brain hormones (such as testosterone, cortisol, and oxytocin) and neurotransmitters (chemical messengers) that allow brain cells to communicate with one another. Researchers are currently investigating how consumer behavior changes when these neuromodulators are altered. In 2015 they found that dosing consumers with testosterone increased their preference for luxury brands; the researchers hypothesized that luxury goods represent social markers and that testosterone makes people more sensitive to status.

- Temporary neural inhibition. Transcranial magnetic stimulation

(TMS) machines use magnetic fields to stimulate or depress nerve cells in the brain, temporarily “knocking out” certain areas in much the way a brain injury does. In 2011 neuroscientists used TMS to repress activity in the posterior medial prefrontal cortex—and found that doing so reduced the degree to which people exhibited socially conforming behavior. Moran Cerf has worked with individuals whose fear and disgust were suppressed or amplified to see whether they exhibited differences in their response to things that might normally be frightening (insects, say, or long-term disasters) and to learn what can be done to make people more susceptible to messages encouraging them to engage with those things—for example, to eat food made from insects, which are a good source of protein with low environmental impact.

5.5.3 Consumers are Unique but Predictable!

Nike is selling its fuel band data to marketing companies as a product. Consumers with a Nike fuel band are gifting Nike and its partner companies with a wealth of data. Nike knows exactly when someone needs a new pair of trainers and that is obviously invaluable information.

We live in a world where consumer behavior is more predictable than ever. Every individual consumer feeds the corporate world tips as to his or her current expectations. In reality, though, only a handful of companies are making the most of these opportunities. The concept â€œbig dataâ€ alone deters a lot of companies. Let’s be honest: most companies can’t even handle â€œsmall dataâ€. After all, how many organizations have a database that’s truly useful and up to date?

In the future, big data management will become a necessary competency if companies are to be highly customer-centric. Consumer expectations evolve. Customers will be less tolerant towards wrong messages at the wrong time. Apart from this low tolerance, a lack of interest will automatically result in a limited impact. On the other hand, customers display a large degree of openness towards the right (commercial) messages delivered at the right time. My study shows that 1 in 3 customers have a very positive attitude towards personalized ads. Customers like to buy products. They also like information on products but only if it’s the right info at the right time. The pointers (content) provided by consumers hand us the ammunition we need to meet this challenge. The modern marketer should turn his attention away from the average consumer and toward the individual consumer.

Case 1: The Weather Channel

The weather channel can predict what products its customers will buy based on local weather predictions. This knowledge is then used to sell very specific ads to local companies. The first warm day in spring in Chicago is good news for the local airco manufacturers. This may be an obvious example, but just like the daily weather forecast, they can predict consumer behavior every day of the year. Digital ads account for half of the weather channel's advertisement revenue. By linking their big data story to the fast adoption of smartphones they are expecting to generate a marked increase in digital revenue. Their goal is to create the perfect ad for every individual consumer.

Case 2: Taco Bell predicts success of a new product

Thanks to their social command center, the popular fast food chain Taco Bell is able to predict the success of product innovations with 90% accuracy. Every year, some 18 million messages on Taco Bell are posted online and the real-time analysis of these data helps them predict success or failure with eerie precision. Thanks to the use of big data, they haven't had a failed product launch in over 15 years.

Case 3: Starbucks can predict the ideal location to open up a new coffee shop

Opening up a new coffee shop is always a calculated risk. In one location the shop may be buzzing with customers whereas 100 yards down the road, that same new Starbucks may be forced to close shop six months later.

Researchers have used Foursquare data to determine which locations are most suited for a new Starbucks. For Starbucks, the degree of competition turned out to be the deciding factor in customer frequency. The study revealed that the Foursquare data in itself are not enough to make the right choice. The prediction becomes more accurate when the Foursquare data are added to existing socio-demographic data. The combination of offline and online data improves the odds of success for a new Starbucks outlet.

Case 4: Wonga.com evaluates creditworthiness

Wonga.com is a financial player in London. The company gives payday loans to consumers and is one of the fastest growing players on the British financial market. They discovered that evaluating creditworthiness based on the classic data and bank blacklists was not enough to make an accurate assessment.

Wonga created its own algorithm to evaluate its clients correctly. They use classic data supplemented with data taken from social media. Every new customer brings new data and makes the assessment more accurate. Adding data from social media gives a clearer picture of consumer spending behavior than impersonal financial data. This has proven particularly useful for the evaluation of creditworthiness and it has also made the organization more profitable.

Chapter 6

NEURAL UNDERPINNINGS OF RISK HANDLING, DEVELOPING PREFERENCE AND CHOOSING

6.1 COGNITIVE PROCESSING

Your brain runs many types of operations, from figuring out how to position your next footfall, to detecting the smell of burning toast, to figuring out how to operate that new electronic device you just bought.

When we talk about the cognitive processing of the brain, we're not talking about the motor acts (such as the footfall) or the sensory acts (smelling the toast), but instead we're centering all of the information we've gathered and using it to operate effectively in the world (operating your new device).

The brain does an enormous amount of cognitive work all the time, taking in information and transforming it, storing it, recovering it, and putting it to work. Such processing allows us to interact intelligently with the world around us.

Examples of cognitive processes

As an example, imagine you're at the grocery store, making your weekly shopping excursion. You look for the items you need, make selections among different brands, read the signs in the aisles, work your way over to the cashier and exchange money. All of these operations are examples of cognitive processing.

The speed of these processes dictates our responses to stimuli, known as our reaction time. Over time, reaction time naturally becomes a little slower, but too much slowing may indicate cognitive impairment. Disproportionate slowing can translate to difficulty avoiding obstacles when walking or driving, trouble making decisions, or a struggle to pay attention.

Fortunately, there are things you can do to slow the progression of the natural aging process. Surround yourself with cognitively stimulating activities, whether in the form of formal education, a new hobby, or a new skill learned from the internet.

Engaging in new tasks leads to more and stronger connections between the cells of the brain. More connections mean more pathways for information to travel; more pathways mean faster processing speed.

6.2 NEURAL ASPECTS OF DECISION-MAKING: COPING WITH RISK

As neuroscience begins to expose the brain mechanisms that give rise to decisions, what do the assortment of facts tell us about such philosophical concepts as responsibility and free will? To many, these concepts seem threatened because of an inability to reconcile a truly free choice with either deterministic brain mechanisms on the one hand or stochastic effects on the other. The former seems to negate the notion of choice by rendering it predictable, at least in principle, or as being under the control of forces external to the agent. The latter reduces choice to caprice, a weak freedom that precludes any meaningful assignment of responsibility. In this essay, we offer an alternative perspective that is informed by the neural mechanisms that underlie decision-making.

Some of these mechanisms point to features that distinguish agents from each other and allow us to understand why one agent might make a better or worse choice than another agent. We suggest that more attention be paid to these aspects of decision-making, and that such attention may help bridge the neurobiology of decision-making (NBDM) and philosophical problems in ethics and metaphysics. Our idea is not that the neurobiology supports one particular philosophical position, but that certain principles of the NBDM are relevant to ethicists of many a philosophical persuasion.

Decision making is the essence of the manager’s job and represents a deliberate process that results in the commitment to a categorical proposition. This chapter explores its neural underpinnings by drawing on neuroscience and neuroeconomics. The neuroscience of decision making is multidisciplinary, drawing from economics, psychology, and neuroscience. A distributed network of brain regions support decision making. The neural basis of topics that are essential to the study of decision making, such as uncertainty, risk, and value-based decisions, is discussed. The chapter also addresses the role of System 1 and System 2 in decision making. The neural basis of other decision-making models, such as the diffusion decision model (DDM) is also explored. The chapter concludes with a discussion of the neural basis of the concepts of exploitation and exploration.

6.3 MATHEMATICAL MIND

'The Mathematical Mind,' refers to the unique tendencies of the human mind, such as order, exactness, exploration, and orientation. Humans also have the unique abilities to imagine, create, and think abstractly. Montessori designed her math materials to incorporate the natural capabilities of a child's mathematical mind.

All children have mathematical tendencies, and all children should be able to enjoy mathematical studies. Dr. Montessori proposed that the introduction of mathematics during the period of the absorbent mind (0-6 years) enables the child to form positive associations with numbers, which can be carried on throughout life. The key is to provide the child with hands-on experiences. For the young child, an explanation is not enough. Dr. Montessori wrote: "Education is a natural process carried out by the child and is not acquired by listening to words but by experiences in the environment." Montessori demonstrated that if a child has access to concrete mathematical materials in his early years, she can come to her own understanding of abstraction concerning the concept. On the other hand, these same skills and facts may require long hours of laborious work if introduced later in abstract forms or simply asked to memorize.

To make a mathematical abstraction, the child must have a prepared foundation of experiences of order, sequence, and sensorial experience of things around her. So it is no accident that the basic materials of the Sensorial apparatus are based on the quantity of ten. Likewise, the area of Practical Life nurtures the mathematical mind of the child through its precision and order. Many materials in the Montessori environment have indirect aims that contribute to the development of the mathematical mind.

At a certain point in development, usually around the age of four, the child enters the sensitive period for numbers, and the child's mathematical nature awakens. She graduates from purely sensorial explorations to interest in specific measuring and counting. Once begun, the child progresses through the math materials sequentially. The first group of exercises is work with numbers 1 to 10. The child learns the quantities from 1 to 10 through a very concrete experience with the number rods. After this, we introduce symbols and the child learns to associate quantity and symbol with the number rods and cards. The sandpaper numbers isolate the symbols for the quantities, and tracing them prepares the hand for writing numerals.

6.4 TROUBLE WITH GAUGING

6.4.1 Framing

A frame in social theory consists of a schema of interpretation that individuals rely on to understand and respond to events. In other words, people build a series of mental filters through biological and cultural influences and use those filters to understand the world. Their choices are influenced by their frames.

When one seeks to explain an event, the understanding often depends on the individual's frame. If a friend rapidly closes and opens an eye, we will respond very differently depending on whether we attribute this to a purely "physical" frame (s/he blinked) or to a social frame (s/he winked).

Though the former might result from a speck of dust (resulting in an involuntary and not particularly meaningful reaction), the latter would imply a voluntary and meaningful action (e.g., to convey humor to an accomplice).

People do not look at an event and then "apply" a frame to it; people constantly project into the world around them the interpretive frames that allow them to make sense of it. People only shift frames when incongruity calls for a frame shift. In other words, people only become aware of the frames that they already use when something forces them to replace one frame with another.

Framing is so effective because it is a heuristic, or a mental shortcut that may not always yield desired results and is seen as a "rule of thumb." According to Susan T. Fiske and Shelley E. Taylor, human beings are by nature " cognitive misers," meaning they prefer to do as little thinking as possible. Frames provide people a quick and easy way to process information. Hence, people will use the previously mentioned mental filters (a series of which is called a "schema") to make sense of incoming messages. This gives the sender and framer of the information enormous power to use these schemas to influence how the receivers will interpret the message.

6.4.2 Endowment Effect and the Loss Aversion

Humans are theorized to be hardwired to be loss averse due to asymmetric evolutionary pressure on losses and gains: "for an organism operating close to the edge of survival, the loss of a day's food could cause death, whereas the gain of an extra day's food would not cause an extra day of life (unless the food could be easily and effectively stored)". Loss aversion was first proposed as an explanation for the endowment effect—the fact that people place a higher value on a good that they own than on an identical good that they do not own—by Kahneman, Knetsch, and Thaler (1990). Loss aversion and the endowment effect lead to a violation of the Coase theorem—that "the allocation of resources will be independent of the assignment of property rights when costless trades are possible".

In several studies, the authors demonstrated that the endowment effect could be explained by loss aversion but not five alternatives: (1) transaction costs, (2) misunderstandings, (3) habitual bargaining behaviors, (4) income effects, or (5) trophy effects. In each experiment half of the subjects were randomly assigned a good and asked for the minimum amount they would be willing to sell it for while the other half of the subjects were given nothing and asked for the maximum amount they would be willing to spend to buy the good. Since the value of the good is fixed and individual valuation of the good varies from this fixed value only due to sampling variation, the supply and demand curves should be perfect mirrors of each other and thus half the goods should be traded. The authors also ruled out the explanation that lack of experience with trading would lead to the endowment effect by conducting repeated markets.

The first two alternative explanation are that under-trading was due to transaction costs or misunderstanding—were tested by comparing goods markets to induced-value markets under the same rules. If it was possible to trade to the optimal level in induced value markets, under the same rules, there should be no difference in goods markets. The results showed drastic differences between induced-value markets and goods markets. The median prices of buyers and sellers in induced-value markets matched almost every time leading to near perfect market efficiency, but goods markets sellers had much higher selling prices than buyers' buying prices. This effect was consistent over trials, indicating that this was not due to inexperience with the procedure or the market. Since the transaction cost that could have been due to the procedure was equal in the induced-value and goods markets, transaction costs were eliminated as an explanation for the endowment effect.

The third alternative explanation was that people have habitual bargaining behaviors, such as overstating their minimum selling price or understating their maximum bargaining price, that may spill over from strategic interactions where these behaviors are useful to the laboratory setting where they are sub-optimal. An experiment was conducted to address this by having the clearing prices selected at random. Buyers who indicated a willingness-to-pay higher than the randomly drawn price got the good, and vice versa for those who indicated a lower WTP. Likewise, sellers who indicated a lower willingness-to-accept than the randomly drawn price sold the good and vice versa. This incentive compatible value elicitation method did not eliminate the endowment effect but did rule out habitual bargaining behavior as an alternative explanation.

6.4.3 Reversal of Preference

Preference Reversal is the situation in which preferences for bundles are shifted after the options are juxtaposed. When bundles are valued separately the decision made on the bundle is different than when they are valued jointly. This is due to the relativity of choices. "Relativity is easy to understand, but there's one aspect of relativity that consistently trips us up. It's this: we not only tend to compare things with one another, but also tend to focus on comparing things that are easily comparable- and avoid comparing things that cannot be easily compared." This is the reason that people tend to change preferences when comparing things separately and jointly. Comparisons become easier once juxtaposed, and more important attributes can be easily compared. Preference Reversal is a theory opposite of the theory of riskless choice. Riskless choice is a theory created by Jeremy Bentham and James Mill that states that decision makers reach utility maximizing choices through consistent and stable choices. Preference Reversal theory however, states that optimal choices might not exist even with the simplest of choices when preferences are contingent on circumstance and whims. When uncertainty is introduced into the decision-making process, the theory of consistent and stable preferences is contradicted. Preference reversals have been noted in a number of settings, but have largely been ignored by economists as many believe that preference reversals are wiped out in marketplace settings. A study by John A. List has proven the opposite however, as he has taken to the marketplace to prove the existence of preference reversals. Preference Reversals violate the theory of the weak axiom of revealed preference. WARP states that if bundle A is strictly preferred to bundle B, and the two bundles are not the same, then it cannot be true that bundle B is directly revealed preferred to bundle A. When presented relative to other goods however, we can see a preference reversal due to relativity

6.5 THE CHOICE DILEMMA

6.5.1 About the Lesser Evil

The lesser of two evils principle, also referred to as the lesser evil principle and lesser-evilism, is the principle that when faced with selecting from two immoral options, the least immoral one should be chosen.

In 2012, Huffington Post columnist Sanford Jay Rosen stated that the idea became common practice for left-leaning voters in the United States due to their overwhelming disapproval of the United States government's support for the Vietnam War. Rosen stated: "Beginning with the 1968 presidential election, I often have heard from liberals that they could not vote for the lesser of two evils. Some said they would not vote; some said they would vote for a third-party candidate. That mantra delivered us to Richard Nixon in 1972 until Watergate did him in. And it delivered us to George W. Bush and Dick Cheney in 2000 until they were termed out in 2009". Opponents of the modern usage of these terms about electoral politics include revolutionaries who oppose the existing system as a whole as well as political moderates who advocate that third parties be given greater exposure in that system. For a particular voter in an election with more than two candidates, if the voter believes the most preferred candidate cannot win, the voter may be tempted to vote for the most favored viable candidate as a necessary evil or the lesser of two evils.

Supporters of lesser-evil tactics in the United States often cite United States politician Ralph Nader's presidential campaigns as examples of what can happen when a third-party candidate receives a significant number of votes. They claim that the mere existence of the third-party candidate essentially steals votes ("tilts" or "tips the scales") from the more progressive of the two main candidates and puts the election in favor of the "worse" candidate—because the small percentage that goes towards the third-party candidate is a part "wasted" that could have instead gone to the lesser-evil candidate. For example, as the Green Party candidate in 2000, Nader garnered 2.7% of the popular vote and as a result, is considered by some Democrats to have tipped the election to Bush. One counterargument is that Nader's candidacy likely increased turnout among liberals and that Al Gore took four of the five states—and thirty of the fifty-five electoral college votes—in which the outcome was decided by less than one percent of the vote. Others argue that supporters of Nader and other third-party candidates draw from voters who would not vote for either Democrats or Republicans.

In the 2016 United States presidential election, both major candidates of the major parties—Hillary Clinton (D) and Donald Trump (R)—had a disapproval rating close to 60% by August 31, 2016. Green Party candidate Jill Stein invoked this idea in her campaign in her slogan "Don't vote for the lesser evil, fight for the greater good".

In his DarkHorse podcast, Bret Weinstein describes his Unity 2020 proposal for the 2020 presidential election as an option that, in case of failure, would not asymmetrically weaken voters' second-best choice on a single political side, thereby avoiding the lesser evil paradox.

In elections between only two candidates where one is mildly unpopular and the other immensely unpopular, opponents of both candidates frequently advocate a vote for the mildly unpopular candidate. For example, in the second round of the 2002 French presidential election graffiti in Paris told people to "vote for the crook, not the fascist". The "crook" in those scribbled public messages was Jacques Chirac of Rally for the Republic and the "fascist" was Jean-Marie Le Pen of the National Front. Chirac eventually won the second round having garnered 82% of the vote.

6.5.2 Decision Conflicts and Choices

Any decisions taken at any level have to take into account the conflicting needs of the individuals who are affected by the decisions and hence conflict resolution is a part of the decision-making process. How well the conflicts are resolved depends on the skill and leadership traits of the decision maker.

After all, any decision that is taken is to balance competing interests and is essentially an allocation of shared resources among the different groups. The point here is that in any organization there are scarce resources that need to be allocated among competing groups and hence the decision maker has to ensure that all the needs and concerns of the different groups are taken into consideration when making the decision.

Since most decisions involve some emotional component as well, the decision makers have to be especially sensitive to the needs of the people who are affected by the decisions.

Consensual decision making ensures that most concerns of the different groups are heard and taken into account. However, in the real-world organizations, decision making by consensus might not be feasible since each group has its own agendas. Hence the decision makers have to ensure that the decisions that they take involve some amount of consultation and some amount of overriding the individual agendas. The reason being that though individual concerns can be taken into account, the decision makers have to keep the interests of the organization in mind and hence proceed accordingly. This is needed so as to prevent individuals and groups hijacking the decision-making process with their agendas.

In most organizations it is common for the decision makers to elicit as much information as possible from the individuals and then only take the decision so as to provide balance and grievance redressal to the affected parties.

Conflicts are inevitable when decisions are taken and the best way to deal with conflicts is to resolve them to the satisfaction of the aggrieved parties. However, this is easier said than done in this competitive world where nobody is willing to lose out on lucrative resources and forego their chances. So it takes quite a bit of skill and managerial abilities not to mention leadership traits to ensure that the decisions result in amicable settlements among the competing groups. The point here is that while it is not possible to please everybody, it is possible to give them a fair hearing and be patient with them so as to give an impression of consensual decision making.

In extreme cases when the competing groups do not agree or abide with the decision, it is left to the higher-ups in the organization to play the role of peacemakers. This is the process of appeal to the senior management as part of the concerns and grievance redressal. This is an essential component of the decision-making process in organizations and only when there is active recourse to appeal can true decision-making work.

6.5.3 Time

Time is familiar to everyone, yet it's hard to define and understand. Science, philosophy, religion, and the arts have different definitions of time, but the system of measuring it is relatively consistent.

Clocks are based on seconds, minutes, and hours. While the basis for these units has changed throughout history, they trace their roots back to ancient Sumeria. The modern international unit of time, the second, is defined by the electronic transition of the cesium atom.

Physicists define time as the progression of events from the past to the present into the future. Basically, if a system is unchanging, it is timeless.

Time can be considered to be the fourth dimension of reality, used to describe events in three-dimensional space. It is not something we can see, touch, or taste, but we can measure its passage.

Physics equations work equally well whether time is moving forward into the future (positive time) or backward into the past (negative time.) However, time in the natural world has one direction, called the arrow of time**.** The question of why time is irreversible is one of the biggest unresolved questions in science.

One explanation is that the natural world follows the laws of thermodynamics. The second law of thermodynamics states that within a closed system, the entropy of the system remains constant or increases. If the universe is considered to be a closed system, its entropy (degree of disorder) can never decrease. In other words, the universe cannot return to exactly the same state in which it was at an earlier point. Time cannot move backward.

6.5.4 Hyperbolic Discounting: A Special Case of the Preference Reversal

Hyperbolic discounting refers to the tendency for people to increasingly choose a smaller-sooner reward over a larger-later reward as the delay occurs sooner rather than later in time. When offered a larger reward in exchange for waiting a set amount of time, people act less impulsively (i.e., choose to wait) as the rewards happen further in the future. Put another way, people avoid waiting more as the wait nears the present time. Hyperbolic discounting has been applied to a wide range of phenomena. These include lapses in willpower, health outcomes, consumption choices over time, and personal finance decisions.

Of particular importance to personal well-being, hyperbolic discounting has been linked to the problems of addiction and self-control. As an example, overweight people may realize that they need to improve their health through more exercise and a better diet. For the future, they vow to forego all short-term temptations in exchange for the greater long-term rewards of improved health. Presumably, they prefer this because they use a small discount rate for all rewards in the distant future. However, after their next meal, they cannot resist having chocolate cake for dessert. They focus on the instant pleasure the chocolate cake can provide and heavily discount the future rewards of better health. After eating the cake, they may once again intend to follow a diet in the future. They believe that next time they will want to, and be able to, turn down the cake. Although these people really want to follow the regimen necessary for better health, the immediate reward from short-term deviations drowns out the heavily-discounted future benefits of healthier eating. Their preference for healthy eating simply does not hold up in the heat of the moment. Similar explanations have also been offered to help account for drug addictions, procrastination, and other problems of willpower.

Hyperbolic discounting also has important consequences for how people choose experiences over time. Given a fixed pool of resources (e.g., money or time), people might want to choose a sequence of experiences to maximize their overall enjoyment. Unfortunately, hyperbolic discounting makes this difficult. People fail to take advantage of liked options that become particularly pleasurable only when rarely experienced. For example, the psychologist Richard Herrnstein proposes that people choose alternatives over time such that the average pleasure is the same across every alternative (this is called melioration). Here, people focus too much on how much pleasure an item provides at the current rate of consumption. They should also consider the potential pleasure that could be obtained by waiting to consume an item. For example, a steak dinner might be especially enjoyable when eaten once a month, yet become nothing special when eaten every other day. In contrast, pizza might remain moderately enjoyable regardless of the rate of consumption. By meliorating between the two options, people fail to maximize their enjoyment. They choose their current favourites (e.g., steak) too often rather than keeping them special for a future occasion.

The economist David Laibson has also used hyperbolic discounting to explain why people simultaneously have large credit-card debts at a high interest rate and pre-retirement wealth growing at a lower interest rate. As predicted by hyperbolic discounting, the rewards provided by buying something today often outweigh the discounted displeasure of future payments. This leads to a sizable credit card debt. However, when thinking about their retirement savings in the far future, people use a much smaller discount rate for delayed rewards. This makes it more attractive to invest in alternatives providing a higher expected return in the longrun. Consistent with hyperbolic discounting, people's investment behavior exhibits patience in the long run and impatience in the short run. People choose to build up sizable credit card debts while also prudently accumulating wealth in homes and retirement programs. The classical economic view of exponential discounting cannot easily account for these personal saving decisions using a single constant discount rate.

6.6 MEMORY-LEARNING CONNECTION

Memory and learning are so closely connected that people often confuse them with each other. But the specialists who study them consider them two distinct phenomena.

These specialists define learning as a process that will modify a subsequent behavior.	Memory, on the other hand, is the ability to remember past experiences.

You learn a new language by studying it, but you then speak it by using your memory to retrieve the words that you have learned.

Memory is essential to all learning, because it lets you store and retrieve the information that you learn. Memory is basically nothing more than the record left by a learning process.

Thus, memory depends on learning. But learning also depends on memory, because the knowledge stored in your memory provides the framework to which you link new knowledge, by association. And the more extensive your framework of existing knowledge, the more easily you can link new knowledge to it.

6.7 INTUITION AND DECISIONS

Intuition in the context of decision-making is defined as a "non-sequential information-processing mode." It is distinct from insight (a much more protracted process) and can be contrasted with the deliberative style of decision-making. Intuition can influence judgment through either emotion or cognition, and there has been some suggestion that it may be a means of bridging the two. Individuals use intuition and more deliberative decision-making styles interchangeably, but there has been some evidence that people tend to gravitate to one or the other style more naturally. People in a good mood gravitate toward intuitive styles, while people in a bad mood tend to become more deliberative. The specific ways in which intuition actually influences decisions remain poorly understood. Snap judgments made possible by heuristics are sometimes identified as intuition.

Intuitive decision-making can be described as the process by which information acquired through associated learning and stored in long-term memory is accessed unconsciously to form the basis of a judgment or decision. This information can be transferred through affect induced by exposure to available options, or through unconscious cognition. Intuition is based on the implicit knowledge available to the decision-maker. For example, owning a dog as a child imbues someone with implicit knowledge about canine behavior, which may then be channeled into a decision-making process as the emotion of fear or anxiety before taking a certain kind of action around an angry dog. Intuition is the mechanism by which this implicit knowledge is brought to the forefront of the decision-making process. Some definitions of intuition in the context of decision-making point to the importance of recognizing cues and patterns in one's environment and then using them to improve one's problem solving. Intuition in decision-making has been connected two assumptions: 1) Tacit decision - previous decisions are affecting and 2) Explicit decision - emotions are affecting.

Intuition's effect on decision-making is distinct from insight, which requires time to mature. A month spent pondering a math problem may lead to a gradual understanding of the answer, even if one does not know where that understanding came from. Intuition, in contrast, is a more instantaneous, immediate understanding upon first being confronted with the math problem. Intuition is also distinct from implicit knowledge and learning, which inform intuition but are separate concepts. Intuition is the mechanism by which implicit knowledge is made available during an instance of decision-making.

6.8 FEELING THE PINCH: PAYING THE PRICE

The Pain of Paying principle, first explored by Prelec & Loewenstein in 1998, explains the psychological link between payment and pleasure (or lack thereof) for the experience or product you are paying for. The simple fact is that people don’t like to part with their money and so making payment can reduce the pleasure taken from making a purchase. It has been proven that spending money actually activates the areas in our brain that are associated with physical pain and feelings of disgust.

Therefore, the more strongly we feel this “pain of paying” when we spend money for something, the less we will enjoy it and it can affect our decisions to make purchases. Studies have shown that certain forms of payment hurt more than others: the more evident, tangible or transparent the payment is, the less we are able to enjoy the pleasure of our purchase. We feel this “pain of paying” less when we pay by credit card or when there is a gap between paying and the time of receiving or using the purchase. Inversely, we feel it more when we have to pay for something immediately or by cash as it really draws attention to the amount that something is costing us.

Automatic payment systems available for online purchases are an example of one way in which some brands are trying to reduce the pain of paying in order to therefore make more sales. Registering your customers' payment details is an effective way of limiting the feeling of making payment and encouraging more purchases. For example, when you buy music or a movie on iTunes, there is no mention of the fact that you are paying, you simply click on the "download" button and, as your bank details are already registered, payment is automatic and therefore less visible and tangible.

6.9 SOCIAL CONTRIBUTIONS TO OPINION FORMING

In recent years, many opinion models have been presented, simulating opinion interactions from a personal perspective. Given an individual interacting rule, the research on opinion dynamics aims to understand the global complex properties in the area of social science. Statistical methods are used to explore how the local rules affect the collective behavior of social agents. In these models, agents hold one of several possible opinions, corresponding to discrete opinion models, or the opinions of agents take value from a certain range of real numbers, i.e., continuous opinion models. Starting from an initial opinion configuration, agents update their opinions according to the interacting rules, and finally the models try to find the formation of public opinion and the conditions of phase transition. Discrete opinion models, such as the Ising model and the Sznajd model, tend to use the analogy of ferromagnetic spins from the science of solid-state physics. Interacting rules are defined in opinion models, and agents update their states following the pattern of ferromagnetic spins, explaining social systems through the analogy of physical systems. In most models, neighboring influence plays a vital role in individual decisions. The final macroscopic state of the system may be consensus, fragmentation, or polarization. In binary opinion models, the consensus state is often favored as a result of imitation and compromises among neighbors, but polarization may also be observed in some other discrete models, such as the model with discrete vectorial opinions and the voter model with three opinions.

Although more and more actual factors are being included in opinion models, the question of whether the models can adequately describe the process of opinion for- mation in real society and explain or even predict social phenomena still requires further exploration. The Finland 2003 election data of the voting sets were applied to verify an opinion model, and it was found that the transient opinion profiles produced by the model are in agreement with the real data. The authors studied political discussions on an Internet forum. They chose several hundred posts and identified their sentiments. Focusing on the growth and topology of the network, they proved that quarrels and personal conflicts between participants boost the growth of discussions. They identified the final state of discussions, finding that opinion exchanges do not lead to consensus formation and opinions tend to go to extremes. Similar results are found. These studies raise the question of whether traditional opinion models suitably describe online opinion interactions, and whether the inter- acting rules reflect the actual characteristics of human behavior. Except for these few studies, due to the limitations of data acquisition and processing capability, large-scale empirical analysis has seldom been carried out to check the validity of opinion models.

The Internet has become one of the most important ways to obtain information. As a popular application service on the Internet, online social media have attracted millions of users. On social media, users interact with others, build relationships, publish posts or replies, and discuss topics. Therefore, the growth of social networks is promoted by users' actions. The process of opinion formation on social media is more complicated than in real society, and information diffuses and evolves more rapidly. For instance, users always discuss issues with others anonymously. They do not know the true names of their neighbors, and they cannot become well acquainted with the personality characteristics of their neighbors. Moreover, users cannot directly see the internal opinions of their neighbors but instead learn about their opinions through the posts they publish.

6.10 BRAND AND THE BRAIN

When you think about creating a successful and memorable brand, where do you put your focus? A lot of companies spend the bulk of their energy thinking about visuals and selling. Where they miss the boat is when they don't allocate any effort to considering the way the human brain reacts to branding and marketing.

Understanding the human brain can make all the difference when it comes to marketing. The human brain is incredibly complex, but it's also prone to dozens of strange quirks and glitches. Cultivating a knowledge of those glitches and how they work can help you take advantage of them to fine-tune your marketing.

Understanding the Human Brain

Let's start with a brief overview of the human brain and how works. The field of neurology studies the human brain from a medical perspective, and neuroscience looks at it from a structural and behavioral standpoint. Each one of these fields has something to offer when it comes to hacking the human brain for marketing purposes.

The Three Brains

The first thing you need to understand is that, from an evolutionary standpoint, humans have three brains. All are encased in the organ we think of as the brain, but each part plays a different role.

Back in the 1960s, neuroscientist Paul D. MacLean coined the term triune brain to describe the structure of the brain. While his structure might be viewed as simple by today's researchers, it still provides a helpful overview to help us understand how the brain works.

1. The reptilian or old brain, which is formally known as the basal ganglia, sits at the base of the skull. This part of the brain is the home of the human stress response, also known as fight-or-flight. It also governs relatively primitive behaviors such as territoriality and aggression.

2. The mammalian brain or middle brain is also referred to as the limbic system, another term coined by MacLean. This is the part of the brain that governs social and parental nurturing, general emotions, and other social behavior.

3. The neocortex or new brain sits at the top of the brain and is the home of higher functions including logic and reason. When you calculate the response to a math problem or analyze marketing statistics, you do It with the neocortex.

As you can see, each part of the brain has a specific function.

How Each Brain Reacts to Marketing

Now let's talk about how the three parts of the brain respond to marketing. The field of neuromarketing examines how the brain responds to various elements of marketing, and it lays out a method for using what we know about the brain to market effectively.

How the Reptilian Brain Responds to Marketing

The reptilian brain is primitive, but that doesn't mean you can ignore it when you craft a marketing campaign. In fact, the needs of the reptilian brain must be met first before you can hope to engage the other parts of the brain.

One way that marketers engage the reptilian brain is by addressing their target audience's fears and doubts. As a rule, when the fear response is active nothing else can happen in the brain because its entire focus is on survival.

You have to understand the things that your audience fears to be able to engage – and then disengage – the reptilian brain.

How the Mammalian Brain Responds to Marketing

The next step is to market to the mammalian brain, which governs emotions and social connections. This is the part of an ad or web page that might address emotions by presenting clear benefits – solutions to the fears and doubts that rule the reptilian brain.

How the New Brain Responds to Marketing

The final step of marketing involves addressing the neocortex or new brain. Only when the reptilian brain's fears and the mammalian brain's emotions have been addressed can you hope to engage the neocortex.

There's a reason that many marketing campaigns don't bring in specifics such as pricing or statistics until the very end. Skilled marketing professionals know that they need to work through their audience's doubts and fears – and reassure them that they have a solution – before talking about pricing.

It's also worth noting that one of the fears you can address earlier in the game is the fear of spending money. If you manage to address that particular fear and convince your audience that your product or service is worth having, it won't be difficult to convince them to spend the money to get it.

6.11 REGRET AND POST DECISION EVALUATION

Because satisfaction and regret are independent of each other and are influenced through different processes, a decision maker may experience one of four conditions: (1) satisfaction and rejoicing (the chosen alternative performed both better than expected and better than the forgone alternative), (2) satisfaction and regret (the chosen alternative performed better than expected but worse than the forgone alternative), (3) dissatisfaction and rejoicing (the chosen alter- native performed worse than expected but better than the forgone alternative), or (4) both dissatisfaction and regret (the chosen alternative performed worse than expected and worse than the forgone alternative). Post-choice valuation is conceptualized here as the sum of satisfaction with the performance experienced and regret based on the alternative option. An additive model is proposed as such models have been supported in previous research. The preceding discussion can be summarized in the following general form

$$PCV = f1(P,E) + f2(P,P'),$$

where PCV is post-choice valuation, $f(\ )$ is a function, $f\,1(P,E)$ is the satisfaction associated with receiving performance level P with a reference point or expected performance level E, and $f\,2(P,P')$ is the regret associated with receiving performance level P with a reference point or performance level of the forgone alternative P'. Negative evaluations (performance is below expectation and below the performance of the forgone alternative) will lead to dissatisfaction in the case of the first component, $f\,1(P,E)$, and regret in the case of the second component, $f2(P,P')$. Positive evaluations (performance is above expectation and above the performance of the forgone alternative) will lead to satisfaction in the case of the first component, $f\,1(P,E)$, and rejoicing in the case of the second component, $f2(P,P')$. There are two more scenarios in which one of the two components is positive and the other is negative. Hence, to replicate the study by Boles and Messick (1995) and test the previously proposed model, the following hypotheses are needed:

HYPOTHESIS 1. Satisfaction is higher when disconfirmation is positive (performance is better than expected) and lower when disconfirmation is negative (performance is worse than expected).

HYPOTHESIS 2. Regret is higher when performance of the forgone alternative is better than performance of the chosen alternative.

HYPOTHESIS 3A. post-choice valuation is highest when the chosen alternative has performed both better than expected and better than the forgone alternative.

HYPOTHESIS 3B. post-choice valuation is lowest when the chosen alternative has performed both worse than expected and worse than the forgone alternative.

The discussion so far has been limited to a two-alternative choice set, which is appropriate for simplicity as all of the hypotheses hold even in choice sets involving three or more alternatives. In reality, however, choice sets rarely consist of two or fewer alternatives. For instance, a consumer may be contemplating which brand of laundry detergent to buy or which movie to see of the ones playing in a nearby theater. Similarly, a purchasing agent for the engineering department of an automobile manufacturer may be considering which computer system to purchase. Would a Novell network (e.g., IBM AS/ 400), a Unix-based network system, a mainframe computer, or a Cray supercomputer be the best choice? Those realistic types of decisions involving three or more alternatives are discussed next.

Choice of Reference Point for Comparison

Regret theory suggests that the forgone alternative becomes the reference point against which regret is computed. However, if two or more alternatives are forgone, which one of them will assume the role of the reference point? Regret theory does not provide any predictions. For example, Researcher states:

With three or more alternatives, would regret be a function of the best outcome of those alternatives not chosen or of the outcome of the second-best alternative? This issue is avoided by restricting consideration to decisions with only two alternatives.

What happens when we are faced with three or more alternatives? Note that not all of the possible alternatives may have been ultimately considered by the decision maker. The initial set may have included six different options, but the actual consideration set may have consisted of only four alternatives and the real deliberation may have been among three alternatives.

Since this paper deals with how people make comparisons after they have observed an outcome, the literature on social comparison may offer some in- sights. Festinger (1954) proposed that people tend to compare themselves against similar others. Recent findings in this literature provide a slightly different prediction. For example, several researchers have shown that the type of comparison depends to a great extent on the valence of the outcome received. When the outcome is positive or favorable, people undertake upward comparisons (com paring themselves with others that received even better outcomes). Conversely, when the outcome is negative or unfavorable, people undertake downward comparisons (com paring themselves with others that received even worse outcomes).

Steele (1988) found that people with available self-resources are willing to make unfavorable comparisons. Hence, if there is no threat to one's self-esteem, the most successful of the alternatives (the one with the highest level of performance) may be selected as the reference point for comparison. The individual may decide to use the best-performing forgone alternative as a reference point because a pleasant outcome has already been experienced. In addition, Spencer, Josephs, and Steele (1993) found subjects with high self-esteem seeking information about others whose performance was very positive. The authors explained that phenomenon as an attempt by the subjects to get more information about the task and thus improve their performance in the future. Hence, after people have been relatively successful and have performed at a high level, they apparently become more willing to compare themselves with others who have performed at an even higher level. In the case of positive disconfirmation or when a positive outcome is experienced, therefore, people may be willing to compare their outcome with what the best-performing forgone alternative would have yielded. Such behavior may be an attempt by individuals to set a higher standard for themselves in the future as well as to get more information about the potential for future growth and improvement. Interest in self-im provement is well documented in research on achievement motivation and is clearly abundant in everyday life in "how-to" books and "pop" therapies available to the public (Wood, 1989). In addition, Taylor and Lobel (1989) foun d that people use upward affiliation as a source of motivation, inspiration, and hope. Hence, the following hypothesis is proposed:

HYPOTHESIS 4. Under positive disconfirmation (performance is better than expected), people select the best-performing forgone alternative as the reference point for comparison.

When a negative or unfavorable outcome is received, the worst-performing forgone alternative may be selected as the reference point for comparison. That method of selecting a reference point may represent a self-enhancement process through which people attempt to maintain a positive self-image and self-perception by minimizing their level of regret. Some evidence for such a process comes from recent social comparison research showing that hedonic needs and a need for positive self-perception may influence selection of the reference group for evaluation of one's own abilities. For example, evidence supports the assertion that one may show preference for downward comparisons if a comparison with similar others leads to feelings of insecurity and low self-esteem.

For example, Pyszczynski, Greenberg, and LaPrelle (1985) found that only subjects who had experienced failure requested information revealing that other subjects also had experienced failure and poor performance. Therefore, individuals may engage in a downward comparison process to enhance feelings of subjective well-being. Wills (1981) suggested that individuals are likely to

TABLE 6.1: Experimental conditions (Study 1)

Condition	Alpha	Beta	Gamma
Positive & favorable	5%	0%	—5%
Positive & unfavorable	5%	15%	10%
Positive & mixed	5%	15%	—5%
Negative & favorable	—5%	—10%	—15%
Negative & unfavorable	—5%	5%	0%
Negative & mixed	—5%	5%	—15%

Note. The level of expectation was set at constant sales (0% increase) for all six conditions

evoke such downward comparisons when they have experienced negative affect due to outcomes that are below their expectation level (i.e., negative disconfirmation). In such cases, individuals may select a reference point that enables them to appear relatively better off. In fact, Taylor, Wood, and Lichtman (1983) found that if no information is available, people sometimes mentally construct a hypothetical worse world or group of less fortunate others with whom they compare themselves. In addition, Spencer, Josephs, and Steele (1993) found that individuals with low self-esteem tend to undertake more downward com- parisons than individuals with high self-esteem. Because threats to self-perception may be most salient for a person who already has had an unpleasant experience (negative disconfirmation or negative outcome), the following hypothesis is proposed:

HYPOTHESIS 5. Under negative disconfirmation (performance is worse than expected), people select the worst-performing forgone alternative as the reference point for calculating regret.

STUDY 1

The purpose of study 1 was to test the hypotheses empirically. Accor ding to the model, two components influence post-choice valuation, one based on disconfirmation (positive vs. negative) and the other based on the comparison with the alternative (favorable vs. unfavorable).

Design

The study has a 2 (disconfirmation of expectations: positive vs. negative) × 3 (com parison with the forgone alternative: favorable vs. unfavorable vs. mixed) 2 between-subjects factorial design. Six experimental conditions were generated. For example, in the first condition (see Table 1), subjects experienced positive disconfirmation and rejoicing. That condition corresponds to the first of the Although the hypotheses could be tested with a 2 × 2 design, the inclusion of another condition may provide more insights on how people react to situations in which some forgone alternatives are performing better and some are performing worse than the chosen alternative. The mixed condition represents the case in which one of the forgone alternatives is performing better and the other is performing worse than the chosen alternative.

two scenarios described previously. Subjects encountered a pleasant experience with a distributor and, in addition, their choice of distributor was the one that yielded the best performance. The level of expectation in the study was set to the level of performance experienced in the previous time period. Note, however, that the level of expectation need not represent the status quo.

Procedure

A business scenario was presented to 150 MBA and executive MBA students at a large university in the Northeast. Each subject was assigned randomly to one of six conditions. The average subject was slightly older than 32 years of age, had more than 10 years of full-time work experience, and had more than 14 full-time employees under his or her supervision. In addition, 62% of the subjects were male, more than half were involved in purchasing decisions for their companies, and more than one third were involved in evaluating a partner firm's performance.

Subjects assumed the role of vice president of an electronics equipment manufacturer who is currently examining three potential distributors that will assist his or her company in distributing its high-tech industrial machinery. Subjects were instructed to read the scenario and proceed with the questions followed at their own pace. The first page consisted of a scenario describing

one of the six conditions. Subjects read about a decision to choose company Alpha, Beta, or Gamma to distribute their products. Company Alpha was the one currently used and the one they had decided to stay with for the next time period. In addition, constant sales (0% growth) were expected for next time period. The level of performance of the chosen company could either exceed or fall short of the level of expectation. Each condition was assigned a particular sales growth rate and one of the conditions (second scenario: positive disconfirmation and unfavorable comparison) is presented in the Appendix.

Because information about all three companies was available, subjects were able to calculate how much better off or worse off they would have been if they had chosen either of the other two alternatives. Subjects were not allowed to turn back to the scenario after they had read it and had decided to proceed with answering the questions. Subsequently, measures of the dependent variables were obtained. To control for potential order effect s, the items measuring the dependent variables were ordered randomly. Subjects took approximately 15 to 20 min to complete the questionnaire.

Measures: Independent Variables

Several measures were used to establish the success of the treatment condition manipulations for type of disconfirmation (positive vs. negative) and com- parison with the alternative (better vs. worse). In addition, subjects were asked several questions to assess their understanding of the scenario and to determine which of the forgone alternatives would constitute the reference point against which the performance level of the chosen alternative would be compared.

Measures: Dependent Variables

In accord with practices reported in the literature, 7-point Likert scales were used for the response measures. Cronbach's (1951) alpha coefficient, "the most popular reliability coefficient in social science research" was used to assess the reliability of the dependent variables. In addition, the construct validity of the dependent variables was assessed. On the basis of results from a factor analysis and the reliability estimates of the variables, one item measuring regret was dropped because of low correlation with the overall construct.

The factor analysis results showed a clean structure and the reliability estimates were α = .96 for satisfaction and α = .82 for regret. A correlation matrix of the individual items provided evidence of convergent and discriminant validity.

Manipulation Checks

One-tailed t tests were used to test the success of the manipulations. The manipulation-check items were always presented after the items measuring the dependent variables. Both manipulations were successful. Subjects in the positive disconfirmation group had more positive disconfirmation ratings than

those in the negative disconfirmation group (1.20 vs. —.86, $p < .001$). In addition, subjects in the better-than-alternative group rated their performance higher than those in the worse-than-alternative group (1.84 vs. —1.10, $p < .001$).

Analysis and Results

A two-way MANOVA was run on the two dependent variables (the means and cell sizes are shown in Table 6.3). Wilks' lambda is statistically significant for both the disconfirmation effect ($F_{2, 139} = 58.37$, $p < .001$) and the comparison with the alternative effect ($F_{4,278} = 19.95$, $p < .001$), but not for the interaction effect ($F_{4,278} = .54$, $p > .1$). The two separate two-way ANOVAs provide support for the hypotheses.

Hypothesis 1 is strongly supported. The main effect of disconfirmation is significant ($F_{1, 140} = 117.03$, $p < .001$) in predicting the subjects' level of satisfac tion. Subjects receiving the positive disconfirmation treatment experienced

TABLE 6.2: Reliabilities and factors loadings (Study 1)

Questionnaire item	Regret (.82)	Satisfaction (.96)
I feel sorry for having chosen company ALPHA	.91	—.01
I feel regretful for having chosen company ALPHA	.90	.01
I am happy with company ALPHA's performance	.01	.97
I am pleased with company ALPHA's performance	.03	.97
I feel satisfied with company ALPHA's performance	—.04	.95

Factor pattern using oblique rotation (Harris-Kaiser).

TABLE 6.3: Means and cell sizes (study 1)

Condition	Satisfaction	Regret	Cell size
Positive & favorable	1.98	—2.04	24
Positive & unfavorable	1.20	.88	26
Positive & mixed	.95	—1.03	26
Negative & favorable	—1.80	—1.26	23
Negative & unfavorable	—1.95	.87	25
Negative & mixed	—1.55	—.35	22

higher levels of satisfaction than their counterparts who received the negative disconfirmation treatment (1.36 vs. —1.65, $p < .001$).

Hypothesis 2 is strongly supported. Because it was not clear how the reference point selection process works, the mixed conditions were excluded from the analysis. Their exclusion was deemed appropriate because, depending on the reference point selected, some subjects may experience regret and others may experience rejoicing. The main effect of performance of the alternative is significant ($F1,94 = 58.56$, $p < .001$) in predicting the subjects' level of regret. Subjects receiving the worse of the two alternatives experienced higher levels of regret than subjects who received the better of the two alternatives treatment (—.65 vs. —1.86, $p < .001$).

Hypotheses 3a and 3b are strongly supported by the data. Again, the mixed conditions were excluded from the analysis. The highest of the four means of post-choice valuation (2.01) is the one for the group that received the positive disconfirmation and the better-than-forgone-alternatives treatment.

Conversely, the lowest of the four means (—1.41) is the one for the group that received the negative disconfirmation and the worse-than-foregone-alter- natives treatment. Further, the difference of the means is statistically significant ($p < .001$), providing further support for Hypotheses 3a and 3b. The other two conditions are not statistically different from each other ($p > .1$), but are statistically different ($p < .001$) from the two conditions mentioned previously. The second highest mean (.27) is the one for the group that received the negative disconfirmation and the better-than-foregone-alternatives treatment. The third highest mean (.16) is the one for the group that received the positive disconfirmation and the worse-than-foregone-alternatives treatment.

Hypothesis 4 posits that under positive disconfirmation, people select the best-performing forgone alternative as the reference point for comparing what is with what could have been. When subjects receiving the positive disconfirmation, treatment were asked to estimate the level of performance they would have received if they had not chosen company Alpha, the following estimates were obtained from the three different subgroups (see Table 6.4). In the case of a favorable comparison (both of the forgone alternatives were worse than the chosen one), the average estimate of the performance level was .04. With the performance of company Beta being at zero and that of company Gamma being —5, the estimate supports Hypothesis 4.

TABLE 6.4: Method for Selecting the Reference Point (Study 1)

Condition	Estimate (SD)	Beta	Gamma	Method
Positive & favorable	.04 (1.12)	0.00	—5.00	Best-performing
Positive & unfavorable	8.92 (2.21)	15.00	10.00	Worst-performing
Positive & mixed	5.59 (2.75)	15.00	—5.00	Average
Negative & favorable	—7.40 (2.66)	—10.00	—15.00	Best-performing
Negative & unfavorable	1.09 (.89)	5.00	0.00	Worst-performing
Negative & mixed	2.04 (2.63)	5.00	—15.00	Best-performing

In the case of an unfavorable comparison (both of the forgone alternatives were better than the chosen one), the average estimate of the performance level was 8.92. With the performance of company Beta being 10 and that of company Gamma being 15, the estimate does not support Hypothesis 4. In fact, the worst-performing forgone alternative seems to have been the reference point for comparison. Finally, in the mixed case (one of the forgone alternatives was better and the other was worse than the chosen one), the average estimate of the performance level was 5.59. With the performance of company Beta being 15 and that of company Gamma being -5, the estimate represents the average of the forgone alternatives and does not support hypothesis 4. Thus, there was mixed support for Hypothesis 4.

Hypothesis 5 posits that under negative disconfirmation, people select the worst-performing forgone alternative as the reference point for comparison. When subjects receiving the negative disconfirmation, treatment were asked to estimate the level of performance they would have received if they had not chosen company Alpha, the following estimates were obtained from the three different subgroups (see Table 6.4). In the case of a favorable comparison (both of the forgone alternatives were worse than the chosen one), the average estimate of the performance level was 7.40. With the performance of company Beta being 10 and that of company Gamma being 15, the estimate does not support Hypothesis 5. In fact, the best-performing forgone alternative seems to have been the reference point for comparison. In the case of an unfavorable comparison (both of the forgone alternatives were better than the chosen one), the average estimate of the performance level was 1.09. With the performance of company Beta being 5 and that of company Gamma being at zero, the estimate supports Hypothesis 5. Finally, in the mixed case (one of the forgone alternatives was better and the other was worse than the chosen one), the average estimate of the performance level was 2.04. With the performance of company Beta being 5 and that of company Gamma being-15, the estimate does not support Hypothesis 5. In fact, the best-performing forgone alternative seems to have been the reference point for comparison. Thus, there was mixed support for Hypothesis 5.

After all of the questions were answered and before the subjects began the demographic section of the questionnaire, an open-ended question asked them to write down their thoughts and feelings based on the previous decision. The answers tended to concentrate on their level of satisfaction and the regret they had experienced. In addition, several respondents stated the level of performance experienced and attempted to provide some reasons for it (e.g., we may need to increase our advertising budget next year). Some of the respondents, however, specifically mentioned the performance level of the forgone alternative. Because the responses could provide some information on the choice of the reference point, they were given to two advanced doctoral students, who were naive to the hypotheses, with instructions to classify the responses as 1) best-performing forgone alternative, 2) worst-performing forgone alternative, both forgone alternatives, and 4) unclear or irrelevant. Because the question was not specifically directed to the selection process, less than half of the responses (40%) could be classified in any one of the first three categories.

After the responses had been coded independently by the two judges, they were examined for consistency. Responses that were not coded consistently were given back to the judges, who were instructed to consult with each other and code each response only if both agreed on its classification. Consensus was reached on all but five responses (92% agreement). The final set of responses consisted of 52 statements coded as one of the first three categories. The responses were assigned to the experimental condition to which they belonged (based on disconfirmation and comparison with the alternative). The last condition (negative disconfirmation and mixed comparison) had only four statements, but the remaining five conditions ranged from a minimum of eight to a maximum of 11 statements. The finding that emerged from the analysis is that indeed disconfirmation does not play a role in determining whether the best- or worst-performing forgone alternative serves as the reference point. In fact, the comparison with the alternative is what seems to determine the choice of reference point. Respondents in the favorable comparison conditions tended to mention the best-performing forgone alternative. In those conditions, 15 of 19 respondents mentioned company Beta or its performance level, which was always better than that of company Gamma. Conversely, 16 of 21 respondents in the unfavorable comparison condition mentioned company Gamma or its level of performance. Finally, respondents in the mixed comparison conditions overwhelmingly (nine of 12) mentioned both forgone alternatives. Those findings seem to validate the inference made previously by examining the estimate of what respondents thought they would have gotten had they selected company Alpha (see Table 4). A chi-square test revealed that there is indeed a significant difference ($y2 = 12.13$, $p < .01$) between selecting a reference point and the condition that the respondents experienced (i.e., type of disconfirmation and comparison with the alternative).

STUDY 2

In Study 2, subjects chose between three different gambles and their decisions involved real money. The setting was intended to heighten the subjects' level of motivation and involvement. As the study design and measures were similar to those in Study 1, only the differences are discussed here.

Procedure

A gambling scenario was presented to 100 students at a mid-sized university in the Midwest. An advertisement was placed in the business school for volunteers to participate in a game with a $100 prize. The game involved a lottery with three versions (see Appendix for details) that differed in the amount of risk involved. The versions were pretested to ensure fairly equal attractiveness to the subjects. All three versions were linked to the same lottery and therefore winning one version meant that the subject would have won the other two versions. The subjects were informed that winning the lottery gave them only the opportunity to win the $100 prize and that their chance of winning the prize was influenced by the lottery they chose. The riskier the lottery, the greater their chance to win the prize. However, losing meant actual loss of money. Subjects were told they could work as a research assistant to pay off their debt.

Unlike Study 1, subjects decided which alternative to choose and which alter- native to forgo. After subjects had selected the version of the lottery, the outcome of the lottery was revealed. The outcome was controlled so that half of the times the players won and half of the times they lost. Subjects who lost were informed shortly after completing the study that they were relieved of their debt. The reason given was that logistical problems had delayed the study to the end of the semester, and the researcher did not want to interfere with the students' performance on their final exams by requiring them to work as a research assistant to pay off their debt. Subjects took approximately 15 min to complete the study. All subjects then were debriefed, thanked for their participation, and dismissed. Shortly thereafter, the names of all participants were entered in a pool and the winner of a random draw was awarded the $100 prize.

Manipulation Checks

Several measures were used to assess the manipulation of the treatment conditions. Subjects who won felt better off than subjects who lost the lottery (1.15 vs. —1.67, $p < .001$). In addition, subjects in the better-than-forgone- alternatives group rated their outcome as more favorable than those in the mixed and worse-than-forgone-alternatives groups (1.95 vs. .27 vs. —2.03, respectively). All three means are statistically different from each other ($p < .001$).

Analysis and Results

The first three hypotheses are strongly supported by the data. The means and cell sizes are shown in Table 5. The main objective of the study was not to replicate study 1, but rather to examine further the process of reference point selection (Hypotheses 4 and 5). Several items were used to identify the forgone alternative selected by the subjects as a reference point for comparison against the chosen alternative. After the outcome of the lottery was revealed, subjects were asked to state which version of the lottery they would have selected if they had not played the one, they actually chose. Hypotheses 4 and 5, that people select the best-performing forgone alternative when the outcome is positive, and the worst-performing forgone alternative when the outcome is negative, were partially supported in Study 1. Study 2 examined the same hypotheses against the competing hypotheses that people select the forgone alternative that is closest in performance to the chosen alternative. In addition, that relationship was examined in a less restricted environment where subjects were more involved and motivated.

The results of Study 2 support Hypotheses 4 and 5. When the outcome was positive, more than 70% of the respondents in all three conditions chose the best-performing forgone alternative (see Table 6). When the outcome was negative, more than 75% of the respondents in two of the three conditions chose the worst-performing forgone alternative. Surprisingly, when both forgone alternatives were better than the chosen alternative, slightly more than 50% of the subjects chose the best-performing forgone alternative.

In addition, the respondents were asked if they would like to review one of the lists that had recorded the names and outcomes of people who had played

the lottery before them. The subjects could choose one of two lists, (1) the names and outcomes of all winners or (2) the names and outcomes of all losers. Of those who won, approximately 70% chose to see the list of winners, about 20% chose to see the list of losers, and the remaining 10% chose the no-feedback option. Of those who lost, more than 70% chose to see the list of losers, about

Table 6.5: Means and cell sizes (study 2)

Condition	Satisfaction	Regret	Cell size
Positive & favorable	2.51	—2.42	15
Positive & unfavorable	1.18	—.03	18
Positive & mixed	2.01	—.79	17
Negative & favorable	—1.04	—2.00	15
Negative & unfavorable	—1.75	1.05	17
Negative & mixed	—1.43	.34	16

Table 6.6: Method for selecting the reference point (study 2)

Condition	Version chosen	Reference point	Method
Positive & favorable	C	B	Best-performing
Positive & unfavorable	A	C	Best-performing
Positive & mixed	B	C	Best-performing
Negative & favorable	A	C	Worst-performing
Negative & unfavorable	C	A & B	Both
Negative & mixed	B	C	Worst-performing

5% chose to see the list of winners, and the remaining 25% chose the no-feedback option. Those findings further support Hypotheses 4 and 5.

Chapter 7

INCREASING THE INNOVATION HIT RATE

7.1 INTRODUCTION

Hit rate is a metric or measure of business performance traditionally associated with sales. It is defined as the number of sales of a product divided by the number of customers who go online, planned call, or visit a company to find out about the product.

Sales can be measured either as the sum of dollars pursued or the number of deals pursued. Accurate calculation requires clear definition of when a sales opportunity is firm enough to be included in the metric, as well as firm disposition of the opportunity (i.e., the deal has reached a point where it is considered won, lost or abandoned).

The hit rate may be measured for the whole sales force or by sales region, sales person or product group. It may be used to benchmark the different sales periods and to benchmark the effectiveness of the own sales force with other companies of the same sector.

Due to the high costs involved with making proposals the hit rate is a very useful tool especially for companies in industrial marketing.

7.2 WHERE IS THE MARKET GOING? THE REAL ESTATE CASE

7.2.1 Who is the Expert?

An expert is somebody who has a broad and deep competence in terms of knowledge, skill and experience through practice and education in a particular field. Informally, an expert is someone widely recognized as a reliable source of technique or skill whose faculty for judging or deciding rightly, justly, or wisely is accorded authority and status by peers or the public in a specific well-distinguished domain. An expert, more generally, is a person with extensive knowledge or ability based on research, experience, or occupation and in a particular area of study. Experts are called in for advice on their respective subject, but they do not always agree on the particulars of a field of study. An expert can be believed, by virtue of credentials, training, education, profession, publication or experience, to have special knowledge of a subject beyond that of the average person, sufficient that others may officially (and legally) rely upon the individual's opinion on that topic. Historically, an expert was referred to as a sage. The individual was usually a profound thinker distinguished for wisdom and sound judgment.

In specific fields, the definition of expert is well established by consensus and therefore it is not always necessary for individuals to have a professional or academic qualification for them to be accepted as an expert. In this respect, a shepherd with 50 years of experience tending flocks would be widely recognized as having complete expertise in the use and training of sheep dogs and the care of sheep. Another example from computer science is that an expert system may be taught by a human and thereafter considered an expert, often outperforming human beings at particular tasks. In law, an expert witness must be recognized by argument and authority.

Research in this area attempts to understand the relation between expert knowledge, skills and personal characteristics and exceptional performance. Some researchers have investigated the cognitive structures and processes of experts. The fundamental aim of this research is to describe what it is that experts know and how they use their knowledge to achieve performance that most people assume requires extreme or extraordinary ability. Studies have investigated the factors that enable experts to be fast and accurate.

7.2.2 Moment and Perception

Moment marketing is the ability to take advantage of ongoing events and creating communications & marketing collaterals around such events. This is used by brands to insert themselves in the ongoing conversations bring relevance to how they market.

Now, what exactly makes moment marketing work?

Two reasons,

- Customers are already part of the 24/7 news cycle, thanks to the immediacy and richness of content available today on demand.
- Brands want to insert themselves into the daily conversations of

their users and since people talk about trends, making use of these trends automatically removes the brands' guess-work.

People are always plugged in and just a few taps away from finding and forwarding the latest content, be it a meme, a viral video, a social media post or a tweet. In fact, half of YouTube subscribers between the ages of 18 and 34 say they would drop whatever they were doing to watch a new video from their favorite channel.

In this article, we will quickly go over why you should consider incorporating moment marketing into your arsenal, give you a few insights into what makes for good moment marketing, share examples and draw your attention to brands that are doing it well.

Perception in marketing is described as a process by which a consumer identifies, organizes, and interprets information to create meaning. Perception is a psychological variable involved in the purchase decision process that is known to influence consumer behavior. Selective perceptions are categorized under two types: a low level of perception, known as perceptual vigilance, and a higher level of perception, known as perceptual defense. These are two optical illusions that illustrate how perception may differ from reality.

7.2.3 Customers Could be Anybody

Customers are the individuals and businesses that purchase goods and services from another business.

Businesses often honour the adage "the customer is always right" because happy customers are more likely to award repeat business to companies who meet or exceed their needs. As a result, many companies closely monitor their customer relationships to solicit feedback on methods to improve product lines. Customers are categorized in many ways. Most commonly, customers are classified as external or internal.

External customers are dissociated from business operations and are often the parties interested in purchasing the final goods and services produced by a company. Internal customers are individuals or businesses integrated into business operations, often existing as employees or other functional groups within the company.

Businesses frequently study their customers' profiles to fine-tune their marketing approaches and tailor their inventory to attract the most customers. Customers are often grouped according to their demographics, such as age, race, gender, ethnicity, income level, and geographic location, which all may help businesses cultivate a snapshot of the "ideal customer" or "customer persona." This information helps companies deepen existing customer relationships and reach untapped consumer populations to increase traffic.

Customers are so important that colleges and universities offer consumer behavior courses dedicated to studying their behavioral patterns, choices, and idiosyncrasies. They focus on why people buy and use goods and services and how it impacts companies and economies. Understanding customers enables businesses to create effective marketing and advertising campaigns, deliver products and services that address needs and wants, and retain customers for repeat business.

7.2.4 Market Prospective

Market prospects are a company's potential future performance in a competitive marketplace. In other words, a company's market prospects are the company's forecasted ability to compete in a marketplace.

Both internal and external analysts compare past company performance with current competition and expectations of future products to develop a company's market prospects. Market prospects can be good or bad and favourable or unfavourable.

For example, Microsoft entered the gaming industry in 2001 with the Xbox gaming console. Many people were excited to see what Microsoft could do with in this new industry, so many analysts said that Microsoft had high or favorable market prospects in the gaming industry.

After a series of marking flops, manufacturing defects, and failed sales forecasts, many investors speculated that the Xbox's once favorable market prospects were declining and Microsoft would soon cease production on the gaming console

Microsoft recalled many of the defective Xbox consoles and continued to build its reputation and gaming license library and today it is one of the most popular, if not the most popular, gaming systems in the world.

Market prospects are often considered one of the building blocks for analyzing a company's future performance. Investors and creditors are not only interested in whether the business can survive, they want to know if the business can succeed and grow. Investors and creditors tend to look at market prospects, liquidity, solvency, and profitability along with other performance metrics when evaluating the future performance of a company.

7.3 MAKING YOUR CUSTOMERS' DAY, AND NIGHT!

7.3.1 The Secrets of Vision

Young and her collaborators have been building their model by incorporating one basic element of vision at a time. They've explained how neurons in the visual cortex interact to detect the edges of objects and changes in contrast, and now they're working on explaining how the brain perceives the direction in which objects are moving.

Their work is the first of its kind. Previous efforts to model human vision made wishful assumptions about the architecture of the visual cortex. Young, Shapley and Chariker's work accepts the demanding, unintuitive biology of the visual cortex as is — and tries to explain how the phenomenon of vision is still possible.

"I think their model is an improvement in that it's really founded on the real brain anatomy. They want a model that's biologically correct or plausible,"

The eye acts as a lens. It receives light from the outside world and projects a scale replica of our visual field onto the retina, which sits in the back of the eye. The retina is connected to the visual cortex, the part of the brain in the back of the head.

However, there's very little connectivity between the retina and the visual cortex. For a visual area roughly one-quarter the size of a full moon, there are only about 10 nerve cells connecting the retina to the visual cortex. These cells make up the LGN, or lateral geniculate nucleus, the only pathway through which visual information travels from the outside world into the brain.

Not only are LGN cells scarce — they can't do much either. LGN cells send a pulse to the visual cortex when they detect a change from dark to light, or vice versa, in their tiny section of the visual field. And that's all. The lighted world bombards the retina with data, but all the brain has to go on is the meager signaling of a tiny collection of LGN cells. To see the world based on so little information is like trying to reconstruct Moby-Dick from notes on a napkin.

“You may think of the brain as taking a photograph of what you see in your visual field,” Young said. “But the brain doesn’t take a picture, the retina does, and the information passed from the retina to the visual cortex is sparse.”

But then the visual cortex goes to work. While the cortex and the retina are connected by relatively few neurons, the cortex itself is dense with nerve cells. For every 10 LGN neurons that snake back from the retina, there are 4,000 neurons in just the initial “input layer” of the visual cortex — and many more in the rest of it. This discrepancy suggests that the brain heavily processes the little visual data it does receive.

Visual Loops

The neural anatomy of vision is provocative. Like a slight person lifting a massive weight, it calls out for an explanation: How does it do so much with so little?

Young, Shapley and Chariker are not the first to try and answer that question with a mathematical model. But all previous efforts assumed that more information travels between the retina and the cortex — an assumption that would make the visual cortex’s response to stimuli easier to explain.

“People hadn’t taken seriously what the biology was saying in a computational model,” Shapley said.

Mathematicians have a long, successful history of modeling changing phenomena, from the movement of billiard balls to the evolution of space-time. These are examples of “dynamical systems” — systems that evolve over time according to fixed rules. Interactions between neurons firing in the brain are also an example of a dynamical system — albeit one that’s especially subtle and hard to pin down in a definable list of rules.

7.3.2 Carl Zeiss Vision: You Will Not Believe Your Eyes!

"Better vision from ZEISS" is a guide for all your questions about vision solutions, lenses and your eyes. At the same time, you get a behind-the-scenes look at ZEISS. We show you what kinds of ZEISS precision lenses and vision solutions we offer, how they came about and what advantages they offer you – always new, always current.

7.4 THE FUTURE OF NEUROSCIENCES

It is clear that the next 50 years will be marked not only by a more comprehensive understanding of the system that allows us to interact with the world around us, but also by fundamental changes in how neuroscience research is accomplished and the very topics that are studied. Among these changes, neuroscientists must acknowledge the importance of diversity. To date, research in male (across species) and right-handed subjects has predominated. Additionally, clinical trials and genetic studies continue to overwhelmingly assess individuals of European descent. These systemic barriers to a comprehensive understanding of neuroscience, and the individual differences contained therein, are driven, in part, by a lack of diversity within neuroscientists themselves. As a result, the field suffers from a lack of understanding with respect to sex differences and the female brain, and FDA- or EMA-approved drugs frequently exhibit decreased therapeutic efficacy in nonwhite populations. Looking forward, we must prioritize greater diversity in both our researchers and our research subjects.

Neuroscience in society

The impacts of neuroscience research extend far beyond the clinic to the classroom, the courtroom, and even the grocery store. Indeed, neuro-technologies are already moving into our homes, promising to boost cognitive abilities, despite insufficient rigorous evidence of efficacy.

Neuroeducation, a field that combines research findings in developmental and cognitive neuroscience with educational strategies, has contributed greatly to our understanding of how students with dyslexia, attention deficit hyperactivity disorder, and other disorders learn. This knowledge has been used to implement changes in math, arts, and science curricula for students with these disorders. Recent evidence also shows that intertwining arts and science education allows students to find more creative and innovative approaches to solving problems. Despite this progress, cognitive psychology and neuroscience are not broadly implemented in standard educational practices of teachers in both primary and higher education. Further application of neuroscience and development of research in this space are beginning to change when mathematics concepts are taught and fundamentally change the way we schedule school days to align with circadian rhythms. Over the course of the next 50 years, we expect to see broader application of neuro educational strategies across age and educational setting.

Neuroscience is becoming increasingly more common in the courtroom as it is used to explain criminal behavior. Its use will increase over the next 50 years as researchers become more knowledgeable about the neurobiological mechanisms underlying decision making. Moreover, as diagnostic tools, human neuroimaging methods in particular, become more advanced and afford researchers greater insight into brain function, these strategies will be used to determine an individual's culpability and even likelihood for recidivism.

Although it may not be apparent in our everyday lives, companies all over the world are using the results of neuroscience research to inform their business practices from office structure to product placement and marketing strategies. This will likely increase over the course of the next five decades as our understanding of the neurobiology of cognition and attention matures. In particular, wearable neurotechnology has the potential to play a prominent role in providing instant consumer feedback allowing personalized marketing strategies that update in real-time. However, companies should exercise caution and follow ethical principles when developing new strategies to generate profit based on neurobiological understanding and techniques.

In conclusion, neuroscience is a vast field. With ~86 billion neurons in the adult human brain, and approximately the same number of non-neuronal cells, it is not surprising that the study of this organ is complex. Furthermore, the nervous system extends far beyond the cranium with neurons projecting to the furthest reaches of the body collecting input and responding to the environment. The progress the field continues to reinforces its enormous potential.

Beyond examining the complexity of the nervous system itself, we must ask ourselves how we study this system of systems. When considering the approach that other scientific fields with seemingly infinite complexity have taken, the study of space comes to mind. While individual nations have embarked on space exploration over the last century, collaboration across disciplines and countries likely contributed to the great strides made thus far. Borrowing from this example, interdisciplinary approaches, with teams of mathematicians, engineers, computer scientists, biologists, and chemists, are key to the continued advancement of neuroscience. Presently, neuroscience is funded in many countries through numerous agencies; however, recent national and international initiatives facilitating large-scale interdisciplinary neuroscience are emerging. The BRAIN Initiative and the Human Brain Project, for example, have not focused on one specific area of neuroscience but instead embraced participation from researchers spanning science, engineering, math, and technology.

The vitality of SfN, whose annual meeting has grown from 1395 to >30,000 attendees per year, highlights its immense value as a central space for scientific dialog and collaboration. Expansion of these centrally coordinated efforts to accelerate brain research as well as a strong community of scientists will be instrumental in elevating the quality and capability of neuroscience research as it continues to explore the unknown.

7.4.1 Science Versus Statistics

There is a great deal of overlap between the fields of statistics and data science, to the point where many definitions of one discipline could just as easily describe the other discipline. However, in practice, the fields differ in a number of key ways. Statistics is a mathematically-based field which seeks to collect and interpret quantitative data. In contrast, data science is a multidisciplinary field which uses scientific methods, processes, and systems to extract knowledge from data in a range of forms. Data scientists use methods from many disciplines, including statistics. However, the fields differ in their processes, the types of problems studied, and several other factors.

The process of creating and comparing models

Many data science problems are addressed with a modeling process which focuses on the predictive accuracy of the model. Data scientists do this by ccomparing the predictive accuracy of different machine learning methods, choosing the model which is most accurate.

Statisticians take a different approach to building and testing their models. The starting point in statistics is usually a simple model (e.g., linear regression), and the data is checked to see if it consistent with the assumptions of that model. The model is improved by addressing any assumptions in the model that are violated. The modeling process is complete when all assumptions are checked and no assumptions are violated.

While data science focuses on comparing many methods to create the best machine learning model, statistics instead improves a single, simple model to best suit the data.

Quantifying uncertainty

Statisticians focus much more on quantifying uncertainty than data scientists. Part of the statistical model-building process is to quantify the precise relationship between each predictor and the outcome being predicted. Any uncertainty about this relationship is also quantified. This process rarely occurs in machine learning.

Big data

Data scientists often deal with huge databases - so big that they cannot be stored on a single computer. While such data sometimes occurs in statistics, it is the exception rather than the norm. Historically, the focus on statistics has been much more about what can be learned from very small quantities of data.

This focus on small data explains why it is important to quantify uncertainty in statistics. When you only have small amount of data, it is easy to confuse signal for noise. The sheer scale of the data which is often studied by data science is also why it is impractical for data scientists to check assumptions.

The types of problems that are studied

Data science problems often relate to making predictions and optimizing search of large databases. In contrast, the problems studied by statistics are more often focused on drawing conclusions about the world at large. This involves working out how best to collect data and measure things, and how to quantify uncertainty about these measurements.

The end-goal of statistical analysis is often to draw a conclusion about what causes what, based on the quantification of uncertainty. By contrast, the end-goal of data science analysis is more often to do with a specific database or predictive model.

Backgrounds of the people working in the fields

Data scientists tend to come from engineering backgrounds. Statisticians are usually trained by math departments.

7.4.2 Brain Specialization and Development

Functional specialization suggests that different areas in the brain are specialized for different functions.

The brain and its functions have been a topic of intense interest. This modern cognitive neuroscience development was derived from the controversial pseudoscience phrenology created by Franz Joseph Gall (1758–1828) and Johann Gaspar Spurzheim (1776–1832). Most well-known for the idea that one's personality could be determined by the variation of bumps on their skull, phrenology came up with the first assumption that different regions in one's brain have different functions and may very well be associated with different behaviours.

Phineas Gage became one of the first lesion case studies in 1848 when an explosion drove a large iron rod completely through his head, destroying one or both of his frontal lobes. He recovered with no apparent sensory, motor, or gross cognitive deficits, but with behaviour so altered that friend described him as "no longer being Gage," suggesting that the damaged areas are involved in "higher functions" such as personality.

Developmental cognitive neuroscience has recently emerged as a new interdisciplinary field that seeks to understand how the physical development of the brain relates to the huge changes in cognitive and psychological abilities that we witness from newborn to adolescent. Advances in child-friendly methods have allowed us to directly investigate how regions of the brain become increasingly fine-tuned for specialized functions. These methods have also helped reveal that postnatal brain development is a dynamic, plastic process in which many emerging functions are shaped by the physical and social environment of the developing child. Indeed, the child helps to further her own subsequent brain development by actively seeking out novel and important types of information from her environment.

From birth to the teenage years the human brain undergoes around a four-fold increase in its total volume. Accompanying this huge increase in brain size are equally dramatic changes in the motor, perceptual and cognitive abilities of infants and children. In terms of their traditional scientific disciplines, the latter phenomena have been the domain of developmental psychologists, while the former were firmly in the realm of the neuroscientist. For decades these fields were pursued in parallel, but largely isolated from each other.

Indeed, for developmental psychologists to refer to neuroscience evidence was sometimes frowned upon because such data were deemed to be misleading or distracting from the core issues of interest. When neuroscience evidence was referred to by developmental psychologists it was commonly from the perspective that a particular developmental change in behavior was 'maturational' – that is, not attributable to learning, and therefore not requiring a psychological level explanation. However, over the last decade or two a number of changes have contributed to the emergence of a new subfield in which scientists are specifically interested in relating developmental changes in perception, cognition and behavior in the developing child to the underlying growth of the brain. This new field has now become known as 'developmental cognitive neuroscience'.

What factors have contributed to the emergence of this new field of developmental cognitive neuroscience (henceforth DCN)? First, and not to be underestimated, is the development of methods that allow us to study human brain structure and function during ontogeny. Some of these methods involve the imaging of brain function in non-invasive ways that are very safe and friendly to infants and their parents. For example, when groups of neurons within the brain fire in synchrony the tiny electrical changes they emit can be measured by passive sponge sensors resting on the scalp (electroencephalography – EEG or event-related potentials – ERP) (Johnson et al. 2001). In another method, tiny changes in the patterns of absorption of low-level light beams can be used to assess changes in the amount of oxygenated (or deoxygenated) blood to particular regions of the brain when they are active (a method called near infrared spectroscopy – NIRS) (Meek, 2002). These methods promise to revolutionize our understanding of functional brain development in humans.

A second factor contributing to the emergence of DCN has been increasing evidence for the plasticity of the brain, particularly during ontogeny. Far from being the unfolding of a rigid genetic plan, much current evidence shows that postnatal human brain development involves a two-way interaction between brain structure and emerging functions. In other words, the postnatal structural and functional development of the brain is influenced by the environment in which it is raised. This is particularly so for humans since our postnatal brain development is considerably slowed down even relative to our most closely related primate cousins. The environment that helps shape our brains involves not only the physical world of objects, surfaces, gravity, and so on, but also the social world of other human beings. Further, the influence of the environment on the brain includes not only aspects of the social and physical world that are specific to individuals (such as being exposed to spoken English), but also aspects that are common to most members of our species (such as being exposed to a language of some kind). This suggests that some of the common aspects of brain structure and function in humans could arise not only because we have genes in common, but also because we share a common environment (with gravity, solid objects, the presence of other humans, etc.).

In addition to new methods for baby-friendly brain imaging, we have new theoretical tools for relating changes in the neuroanatomy of the brain to the psychological and computational functions it subserves. The rise of a class of brain-inspired psychological models, sometimes called 'connectionism' or neural network models, formalizes how changes in networks of neurons and their connections bring about changes in computation and behavior (connectionist or neural network modelling). The purpose of these computer models is not just to simulate changes in cognition and behavior during development, but also to generate testable predictions for future research.

Even though DCN is a relatively young discipline, a number of themes of discovery are emerging. Prior to the advent of DCN, developmental psychology was rife with debate between nativists, who argued for the importance of genetic specification of core principles that structure cognition, and empiricists who emphasized the role of learning and experience. While pockets of evidence from DCN can be selected to support either of these views, the majority of scientists in this new field are struck by the evidence that human functional brain development is a constructive process in which the state of the brain at one (earlier) stage helps it to select the appropriate experience necessary for advancing to the next (later) stage. In other words, human postnatal brain development is what is termed a self-organizing process.

For example, much evidence shows that babies and young children are most interested in new events and stimuli – things that they don't yet understand. By spending time looking at a new object or event, they are exposing their brains to a new source of information that, in turn, will contribute further to their own brain development. Some readers may detect that this constructivist perspective resembles in at least a general way the views of Jean Piaget, one of the founders of developmental psychology. While Piaget did not have any of the powerful theoretical tools or methods at our disposal today, it is interesting to speculate on how he would view current research in the field.

Perhaps the clearest example of babies seeking out the aspects of the environment necessary for their own subsequent brain development comes from the attention and effort they devote to interacting with other humans, and particularly their primary caregivers. From birth, human newborns orient toward and respond to faces, particularly to a smiling face with direct (mutual) gaze. This newborn bias ensures that, from birth, babies engage other human beings in social interaction. Studies using ERP and NIRS methods have shown that at a few months of age babies' processing of other people's faces is deeper and more detailed when accompanied by the cues associated with communicative interaction, such as direct gaze.

Furthermore, objects that are presented or gazed at by adults tend to be subsequently processed more deeply, and recognized better, by young babies. Thus, human babies are biased to seek out information necessary for their own subsequent brain development from adult humans. And, of course, parents are predisposed to provide this information for their offspring in a variety of ways.

Another theme from recent work in DCN is that of the emerging specialization of functions within the human brain. Contrary to the popular view that postnatal brain development involves 'switching on the lights' in particular regions of the brain at different ages, functional brain-imaging studies are showing us that nearly all parts of the brain begin life responsive to sensory stimuli, but that some regions are poorly tuned. That is, these regions begin life capable of being activated under a wide variety of different circumstances and with a range of different sensory stimuli. During development these responses become more specifically tuned to particular task contexts or sensory stimuli. This is because the regions become sculpted to support increasingly specific computations. For example, regions that are selectively tuned to faces in adults show a much broader response profile in young children in that the regions in question respond equally well to other visual objects. With age, the face-selectivity of the region increases even to the extent of selectivity depending on the particular tasks related to face perception (e.g., individual recognition vs. expression recognition vs. eye gaze direction detection). Thus, at least for the overlying cerebral cortex, much of human postnatal development can be characterized as the gradual emergence of increasingly specific functions within regions of the brain.

A specific part of the cortex that has been associated with higher cognitive functions such as inhibition, working memory and planning is the prefrontal cortex – the region of the brain that lies behind our forehead.

The textbook view is that this region is silent over the first year of life, and that it becomes functional in stages beginning at around 12 months. Recent work in DCN suggests that while the functions that the prefrontal cortex supports clearly get more advanced as childhood proceeds, the region is active from at least the first few months after birth. This poses something of a paradox. Why is it that the prefrontal cortex is active from early in life, yet the aspects of cognition associated with the region in adults emerge only slowly during childhood?

One answer to this question may be the important role that the prefrontal cortex plays in the acquisition of new skills. Functional imaging of adults while they acquire complex new perceptual or motor skills shows that this region is activated during the early stages of learning the new skill. Once the skill has been acquired, however, the involvement of the region decreases, or even disappears, and other parts of brain take over. The newborn infant has to acquire a vast range of skills that seem mundane to us as adults. For example, learning to use vision and proprioceptive feedback to successfully reach for and grasp an object takes several months of failed attempts and near misses. Such seemingly simple tasks to adults may be as challenging to the infant brain as learning to drive is for an adult. The hypothesis that the prefrontal cortex is important for the acquisition of basic motor and perceptual skills in infants is currently being investigated by researchers in DCN.

Another theme of discovery in DCN concerns the pathways of progression in development, sometimes called 'developmental trajectories. Research here is comparing typically developing infants and children with those with developmental disorder like Williams syndrome, fragile-X and autism. In some cases, close comparison of these syndromes is revealing that developmental trajectories can diverge in initially subtle ways, but that this deviation becomes compounded later on by increasingly atypical interactions with the social and physical environment as development proceeds. For example, a baby at-risk for autism may begin with slightly atypical patterns of social interaction with their caregivers that then become compounded with development as they elicit slightly atypical responses from others. In other cases, infants and children at risk may recover and re-join the typical developmental trajectory at a later point in development.

What of the future? DCN is clearly a young discipline and, like a toddler, much work remains to be done to bring together the fragments of knowledge that we have acquired so far into a coherent overall picture.

Nevertheless, of all the cognitive and neurosciences DCN is probably the field with the most scope for practical and clinical application. First, as mentioned above, in DCN investigators often study atypical or at-risk babies and children alongside typically developing ones. Understanding the brain basis of developmental disorders such as autism gives us insights both into the immediate causes of cognitive and behavioral disturbance, and into the developmental causes of the full profile of symptoms. For example, some recent studies raise the possibility that measures of brain function may provide an earlier warning sign of a later diagnosis of autism than behavioral symptoms.

Another avenue of application for DCN is education. While educational packages based on folk neuroscience myths are quite popular in some schools, there still remains a big gulf between basic neuroscience and classroom practice. Recent interest in 'educational neuroscience' suggests that this gulf will be bridged in the near future.

Turning to preschoolers, there are a variety of populations of infants who are at risk for either genetic or environmental reasons. For example, children raised in low socio-economic status homes tend to be at risk for a variety of adverse mental health and mental ability outcomes. An important societal agenda for the future will be to see whether we can identify babies most at risk and deliver targeted and theoretically motivated environmental enrichment programmers.

A final area of application is for industrial developments in artificial intelligence and robotics. Despite the areas in which present-day computers outsmart humans, the human child's remarkable ability to learn from others remains unparalleled. Thus, studying how the human brain acquires expertise and knowledge over a lifetime may provide important insights for those trying to develop a more natural artificial intelligence.

These potential areas of application, when taken along with its basic science interest, suggest a healthy future for developmental cognitive neuroscience.

7.4.3 Disease Prevention, Vocation Finder, Dating, and More

Disease prevention, understood as specific, population-based and individual-based interventions for primary and secondary (early detection) prevention, aiming to minimize the burden of diseases and associated risk factors.

Primary prevention refers to actions aimed at avoiding the manifestation of a disease (this may include actions to improve health through changing the impact of social and economic determinants on health; the provision of information on behavioral and medical health risks, alongside consultation and measures to decrease them at the personal and community level; nutritional and food supplementation; oral and dental hygiene education; and clinical preventive services such as immunization and vaccination of children, adults and the elderly, as well as vaccination or post-exposure prophylaxis for people exposed to a communicable disease).

Secondary prevention deals with early detection when this improves the chances for positive health outcomes (this comprises activities such as evidence-based screening programs for early detection of diseases or for prevention of congenital malformations; and preventive drug therapies of proven effectiveness when administered at an early stage of the disease).

It should be noted that while primary prevention activities may be implemented independently of capacity-building in other health care services, this is not the case for secondary prevention. Screening and early detection is of limited value (and may even be detrimental to the patient) if abnormalities cannot be promptly corrected or treated through services from other parts of the health care system. Moreover, a good system of primary health care with a registered population facilitates the optimal organization and delivery of accessible population-based screening programs and should be vigorously promoted.

Health promotion is the process of empowering people to increase control over their health and its determinants through health literacy efforts and multisectoral action to increase healthy behaviors. This process includes activities for the community-at-large or for populations at increased risk of negative health outcomes. Health promotion usually addresses behavioral risk factors such as tobacco use, obesity, diet and physical inactivity, as well as the areas of mental health, injury prevention, drug abuse control, alcohol control, health behavior related to HIV, and sexual health.

Disease prevention and health promotion share many goals, and there is considerable overlap between functions. On a conceptual level, it is useful to characterize disease prevention services as those primarily concentrated within the health care sector, and health promotion services as those that depend on intersectoral actions and/or are concerned with the social determinants of health.

Scope of the function

Disease prevention

- Primary prevention services and activities include:

Vaccination and post-exposure prophylaxis of children, adults and the elderly;

Provision of information on behavioral and medical health risks, and measures to reduce risks at the individual and population levels;

Inclusion of disease prevention programmes at primary and specialized health care levels, such as access to preventive services (ex. counselling); and

Nutritional and food supplementation; and

Dental hygiene education and oral health services.

- Secondary prevention includes activities such as:

Population-based screening programmes for early detection of diseases;

Provision of maternal and child health programmes, including screening and prevention of congenital malformations; and

Provision of chemo-prophylactic agents to control risk factors (e.g., hypertension)

Health promotion

- Policies and interventions to address tobacco, alcohol, physical activity and diet (e.g., FCTC, DPAS, alcohol strategy and NCD best-buys)
- Dietary and nutritional intervention should also appropriately tackle malnutrition, defined as a condition that arises from eating a diet in which certain nutrients are lacking, in excess (too high in intake), or in the wrong proportions
- Intersectoral policies and health services interventions to address mental health and substance abuse

- Strategies to promote sexual and reproductive health, including through health education and increased access to sexual and reproductive health, and family planning services

- Strategies to tackle domestic violence, including public awareness campaigns; treatment and protection of victims; and linkage with law enforcement and social services.

Support mechanisms for health promotion and disease prevention

- Multisectoral partnerships for health promotion and disease prevention

- Educational and social communication activities aimed at promoting healthy conditions, lifestyles, behavior and environments (see EPHO VII)

- Reorientation of health services to develop care models that encourage disease prevention and health promotion

- Risk communication.

7.5 PLANNING SUCCESS: THE INNOVATION ROADMAP

Succession planning is a strategy for identifying and developing future leaders at your company — not just at the top but for major roles at all levels. It helps your business prepare for all contingencies by preparing high-potential workers for advancement.

Here are seven tips for kick-starting the succession planning process at your company.

1. Be proactive with a plan

Sometimes, you'll know well in advance if a hard-to-replace team member is going to leave the company — a planned retirement is a good example. But other times, you'll be caught off-guard by a sudden and potentially disorienting staff departure. That's why you need a plan — now.

2. Pinpoint succession candidates

Once you have a handle on the ripple effect that the departure of certain employees might cause, choose team members who could potentially step into those positions.

3. Let them know

In private meetings, explain to each protege that they're being singled out for positions of increasing importance. Establish an understanding that there are no guarantees, and the situation can change due to circumstances encountered by either the company or the succession candidates themselves.

4. Step up professional development efforts

Ideally, you have already been investing in the professional development of those you select as your succession choices. Now that preparation needs to be ramped up. Job rotation is a good way to help your candidates gain additional knowledge and experience. And connecting them with mentors can boost their abilities in the critical area of soft skills: The best leaders have strong communication skills, as well as polished interpersonal abilities, such as empathy and diplomacy.

5. Do a trial run of your succession plan

Don't wait until there's a staffing crisis to test whether an employee has the right stuff to assume a more advanced role. Have a potential successor assume some responsibilities of a manager who's taking a vacation. The employee will gain valuable experience and appreciate the opportunity to shine. And you can assess where that person might need some additional training and development.

6. Integrate your succession plan into your hiring strategy

Once you've identified employees as successors for critical roles in your organization, take note of any talent gaps they would leave behind if tapped. That can help you identify where to focus your future recruiting efforts.

7. Think about your own successor

If you decide to take advantage of a new opportunity or retire from the workforce, even your role could someday require backfilling. When making a succession plan for your organization, be sure to include your own position. Which employee could you see stepping into your shoes one day? And what can you do, starting now, to help that person prepare for the transition?

Your staff members aren’t fixed assets — and changes in your team’s lineup are inevitable. You may not always be able to predict a valued employee’s departure from the firm. But through effective succession planning, you can pave the way for the continuity so critical to your business’s future.

7.5.1 ‘Leadertips’ to Winning Innovation

Leadership is often described as a set of skills that can be enhanced and trained. Inspired by my work with helping business owners advance, here are eight tips for being an effective leader:

1. Learn to lead by example.

At some point in their careers, everyone has had a boss who has asked them to do something they don't usually do, such as come in early for a meeting, and then the boss was late for it. Having the "do as I say" attitude doesn't make you likable and doesn't earn you the respect of your team. A good leader is one who leads by example and does what they expect everyone else to do. If you expect your team to be hard workers, then you should be a hard worker too. By practicing what you preach, you earn the respect and loyalty of your team, and before long, you'll see that they're following your example.

2. Be goal-oriented.

Instead of focusing on the problem at hand, an effective leader instead directs attention toward the solution. Instead of worrying and complaining about the issues, they focus on the objectives and then turn their energies toward creating a plan and strategy to achieve those objectives. An effective leader prioritizes so they can get the most important and urgent things done first.

3. Take responsibility.

Instead of pointing fingers and playing the blame game when things go wrong, a good leader takes responsibility for the team's actions and their consequences. By being willing to take responsibility, you prove that you're worthy of trust and respect.

4. Share the glory.

We've probably all had a boss who took all the credit for the team's hard work and success, right? This is not an effective leader. An effective leader is one who is team-oriented and more than happy to share the glory and credit for a job well done with the team. They admit that the success and achievements are due to the team's joint efforts. A leader is only as good as the team behind them. By sharing the glory, an effective leader can earn the admiration and respect of the team. After all, no one wants to follow a selfish leader.

5. Know how to develop a team.

One of the primary traits of an effective leader is the ability to develop team members through training, teaching or coaching. The team will not be able to achieve the goals of the organization without this training.

An effective leader can build people up and create a stronger team, which benefits everyone involved. They can do this because they pay attention to the strengths and weaknesses of the team as a whole, as well as those of each team member. They have excellent communication skills, which they can use to build relationships with and among team members. By building good interteam relationships, they create a greater level of productivity.

6. Become a master of communication.

Excellent communication skills are necessary to become an effective leader. However, communication is not just about expressing what you want to happen -- it's also about being able to truly listen to others. An effective leader not only expresses their ideas and strategies persuasively and clearly but also truly listens to feedback with an open mind.

7. Be courageous and assertive.

In many cases, the leader of a team has to venture into new territory, which means they have to face the unknown and take risks or break rules. In order to do this, a leader must be able to speak up about the things that truly matter and be assertive about what they need and want from their team and for their team. An effective leader is willing and ready to face any challenges and obstacles so they can achieve their own goals and the goals of the organization.

8. Be confident.

Projecting confidence is probably the most difficult characteristic to develop. Some people are naturals when it comes to this, but you can develop a greater sense of self-assurance. Part of this confidence is having faith and feeling secure in yourself and not needing to be accepted and loved by others, as well as being able to prove that you have the competencies and the skills to be an effective leader and to lead the team to its common goal.

Chapter 8

THE RIGHT SENSORY MIX

8.1 INTRODUCTION

"The Right Sensory Mix" is one of the four best marketing books in 2011 according to the American Marketing Association Foundation. The Berry-AMA Book Prize is awarded annually be the Foundation (AMAF) and recognizes books whose innovative ideas have had significant impact on marketing and related fields.

8.2 WHAT MAKES CONSUMERS SWITCH TO ANOTHER PRODUCT? THE HAIR CASE

8.2.1 The Price Fairy Tale

There is little doubt about the fact that your customers want value for their money. You only need to consider anyone who walks into your store to shop. Let's say you're a convenience store and a customer pop in on their way home from work to pick up a few items.

For the sake of this example, their shopping list includes Bread, Milk, Cereal, and a variety of other smaller items. Notice how it's a list of products and not brands? Of course, they might have an idea of what type of Cereal brand they want to buy. However, until they reach the shelf, there is every possibility for them to change their mind.

The probability of them changing their mind increases when they get to the shelf and find a product that is priced far higher than they had expected. Or, if their preferred choice is out of stock. That hesitancy, is the first step towards switching to an alternative product. It has them thinking. The second step is if there is similar product merchandised nearby at a lower price, and the customer sees it as equal. If their preferred choice is out of stock, they need a viable alternative.

That said, there are a few actions you can take to stop this from happening. Most efforts, quite naturally, revolve around reevaluating your pricing strategy.

In this instance, the first action to take would be to look at your target market. Who is your customer? What are they able to spend? More importantly, what are they willing to spend on the product? Are they driven by a lower price or the value of the product?

Once you've established that, it's time to turn to your competitors. What are they charging for your equivalent brand? What does their offering include in comparison to your product? Does the value they offer beat your product? Then, of course, there are the economic and market conditions to consider when calculating the most appropriate retail price.

8.2.2 Unmet Requirements

One line of research has investigated humans' behavioral and neural responses to social rejection. In healthy human adults, social rejection (i.e., being explicitly and deliberately rejected by one or more interaction partner/ s) can cause negative emotions and can lead to increased efforts to affiliate with others, but can also lead to withdrawal and antisocial behaviour. The experience of social rejection activates brain areas associated with processing of aversive states like physical pain, such as bilateral anterior insula and anterior cingulate cortex (ACC). Furthermore, a positron emission tomography (PET) study found that social rejection increases opioid release in ventral striatum, amygdala, midline thalamus and periaqueductal grey (PAG) suggesting that endogenous opioids have a role in reducing the experience of social pain.

Interestingly, dopamine neurons in the DRN/PAG which were found to drive increased social preference and motivation to seek social contact in rodents, were also shown to be associated with physical pain processing. Thus, while social rejection in humans appears to be represented in different brain areas than social isolation in animal models, both might represent a neural correlate of an aversive emotional state.

However, it might be that social rejection is conceptually not the same state as social isolation. Being deliberately rejected by another person is an aversive act that causes strong aversive emotional responses. Isolation, on the other hand, does not include any aversive acts by others, but is characterized by a lack of social interactions. Thus, it is likely that social rejection and social isolation affect social behavior via different mechanisms.

A second line of research – initiated and advanced by John Cacioppo – has studied the outcomes of perceived loneliness. Feelings of loneliness are conceptualized as serving the purpose to signal a deficiency to the organism and to seek social contact. Yet, the results in humans are not straightforwardly analogous to effects of social isolation in rodents. Unlike isolated rodents, loneliness seems to be associated with lower social approach motivation: Loneliness is associated with higher self-centeredness, preference for larger interpersonal space, increased motivation to avoid bad social outcomes and decreased motivation to approach good social outcomes. Lonely individuals pay more attention to negative social stimuli than nonlonely individuals. In addition, lonely individuals tend to interpret the behaviour of others in a more negative light than nonlonely individuals. Furthermore, loneliness was shown to be associated with lower prosocial behaviour, although public display of decisions reversed this relationship. Indeed, the latest version of John Cacioppo’s evolutionary model on loneliness states that the motivation to reengage in social contact can be hampered by various types of fears and cognitive biases that lead to self-centeredness and social avoidance.

There is some evidence linking human loneliness to altered function in dopaminergic reward regions. For example, a seminal paper from John Cacioppo has shown that lonely individuals show decreased activation of the ventral striatum in response to viewing pleasant social pictures compared to non-lonely individuals. In addition, lonely individuals showed increased visual cortex activation to unpleasant social pictures. This was interpreted as evidence that lonely individuals are less rewarded by social stimuli while paying more attention to distress of others. However, a recent study failed to replicate these results in a larger sample. Another study found that lonely people show increased activation in the ventral striatum when viewing pictures of close others compared to non-lonely people.

However, an important caveat of research on loneliness is that it mostly employs a correlational approach: studying individuals who are chronically lonely. Thus, it is unclear whether the identified effects are consequences, causes, or risk factors for loneliness. For example, it might be that people who have lower social approach motivation are more likely to become lonely. Unfortunately, experimental approaches to induced acute isolation are practically non-existent in human participants, making direct comparisons between loneliness research in humans and social isolation research in rodents difficult.

8.2.3 Birds of a Feather Flock Together

Those with similar interests or of the same kind tend to form groups.

Example:
A: John and James seem to get along really well

B: Well, birds of a feather flock together. They both love reading comics

In nature, birds of the same species often flock together as a safety precaution, since congregating in large groups would reduce their risk of predatation. This behavior of birds is where this idiom originates from.

8.3 HEALTH, WELL-BEING, AND LIFESTYLE

8.3.1 Ayurveda, The Sense of Digestion

Ayurvedic medicine ("Ayurveda" for short) is one of the world's oldest holistic ("whole-body") healing systems. It was developed more than 3,000 years ago in India.

It's based on the belief that health and wellness depend on a delicate balance between the mind, body, and spirit. Its main goal is to promote good health, not fight disease. But treatments may be geared toward specific health problems.

In the United States, it's considered a form of complementary and alternative medicine (CAM).

Ayurveda and Your Life Energy

Students of CAM therapy believe that everything in the universe – dead or alive – is connected. If your mind, body, and spirit are in harmony with the universe, you have good health. When something disrupts this balance, you get sick. Among the things that can upset this balance are genetic or birth defects, injuries, climate and seasonal change, age, and your emotions.

Those who practice Ayurveda believe every person is made of five basic elements found in the universe: space, air, fire, water, and earth.

These combine in the human body to form three life forces or energies, called doshas. They control how your body works. They are Vata dosha (space and air); Pitta dosha (fire and water); and Kapha dosha (water and earth).

Everyone inherits a unique mix of the three doshas. But one is usually stronger than the others. Each one controls a different body function. It's believed that your chances of getting sick -- and the health issues you develop -- are linked to the balance of your doshas.

8.3.2 Becoming Consumers' BFF

Companies have the potential to create these amazing bonds and solidify lifelong loyalty if they invest in their consumers like you would your friends. I've recognized three key learnings from my friendship with Sara that companies should adopt to reach best friend status with their consumers (or as I'll be calling it, best brand status).

Although we grew up down the street from each other, Sara and I now live nearly 800 miles apart. I can confirm - long distance relationships suck. But Sara and I make it a priority to keep in touch by calling each other every chance we get. We fill each other in on the moving pieces of our lives, from jobs to family to that funny joke I heard today. Even though it's been almost two years since we've seen each other in person, I feel like Sara and I are as connected as ever.

This is the first and most important key to a best brand's success - communication. A best brand knows that in order to build relationships, they need to stay in touch with their consumer.

However, out of the millions of companies in the world, very few are actually good at talking to their customers. With social media and mobile connecting everyone to everything, there is no excuse for brands to neglect or ignore their consumers. However, data shows that a disconnect between companies and their consumers is the norm. Here are a few stats about interactions that might make your jaw drop:

- 5 out of every 6 requests made by consumers on social media to a business go unanswered.
- The volume of social media requests has increased 77% year over year, but responses from businesses have only increased by 5%.
- 70% of companies ignore customer complaints on Twitter
- 7 of every 8 customer messages go unanswered within 72 hours

Brands that invest in analyzing data and understanding their persona's consumer journey benefit through a customized communication methodology that resonates with their audience. Those best brand companies create multiple positive associations by interacting with their consumers or being leaders in social media (Taco Bell), giving the consumer the benefit of the doubt (American Express), throwing in lagniappes and surprise experiences (Domino's), or even customizing the customer service experience (Apple). These are the brands that keep coming up in conversation, and keep crushin' it in their respective industries.

8.4 DESIGNING PRODUCTS: THE SENSORY PROFILES

8.4.1 Core versus Peripheral Features

The core a central region in an economy, with good communications and high population density, which conduce to its prosperity—is contrasted with the periphery—outlying regions with poor communications and sparse population (for examples, see unemployment). 'Either defined in geographical or sociological terms, the center represents the locus of power and dominance and importantly, the source of prestige, while the periphery is sub-ordinate. Simply put, a center–periphery relationship is about hierarchy'

Cores are associated with high wages, high technology, and high profit inputs and outcomes. Geographically, these processes have tended to concentrate and segregate—this produces places where core processes dominate and places where peripheral processes dominate. 'For short-hand purposes these may be designated as "core" and "periphery" but they must never be seen as purely one or the other: so-called "core countries" encompass numerous, if minority, peripheral processes; and the opposite is so for "peripheral countries"'. 'When transport costs fall below a critical value, a core–periphery spontaneously forms, and nations that find themselves in the periphery suffer a decline in real income'. Research adds congestion costs and infrastructure to Krugman's model, and researchers Economic introduce Romerian product innovation growth into the model. reseal develop a core–periphery model in which the agglomeration effects from concentrating R&D activity in the core, combined with relatively low transportation costs, generate sufficient value added to more than compensate the periphery for the loss of R&D activity.

8.4.2 Designing and Testing

Test design is a process that describes "how" testing should be done. It includes processes for the identifying test cases by enumerating steps of the defined test conditions. The testing techniques defined in test strategy or plan is used for enumerating the steps.

The test cases may be linked to the test conditions and project objectives directly or indirectly depending upon the methods used for test monitoring, control and traceability.

The objectives consist of test objectives, strategic objectives and stakeholder definition of success.

When to create test design?

After the test conditions are defined and sufficient information is available to create the test cases of high or low level, test design for a specified level can be created.

For lower-level testing, test analysis and design are combined activity. For higher level testing, test analysis is performed first, followed by test design.

There are some activities that routinely take place when the test is implemented. These activities may also be incorporated into the design process when the tests are created in an iterative manner.

An example of such a case is creation of test data.

Test data will definitely be created during the test implementation. So, it is better to incorporate it in the test design itself.

This approach enables optimization of test condition scope by creating low- or high-level test cases automatically.

Chapter 9

NEURAL BASES FOR SEGMENTATION AND POSITIONING

9.1 PERSONALITY TRAITS AND IMPLICATIONS FOR CONSUMER BEHAVIOR

Sometimes referred to as OCEAN, CANOE, or the five-factor model, the big 5 model encompasses five key attributes of a consumer's personality. Those five traits are openness, conscientiousness, extraversion, agreeableness, and neuroticism.

1. **Openness means being open to experiencing new or different things.** Those who score high on this trait tend to be intellectually curious, willing to try new things, and more creative or unconventional. Those who score low on this trait are usually opposed to change and struggle with abstract thought.

2. **Conscientiousness refers to acting in an organized or thoughtful way.** Those who score high on conscientiousness tend to be self-disciplined, strive for achievement, and follow a plan or schedule. Scoring low on this trait, you may be more unstructured in your approach to tasks and procrastinate more often.

3. **Extraversion is seeking stimulation in the company of others.** Those who score high on this trait don't mind being the center of attention and tend to be very social and energetic. Those who score low on extraversion often prefer to be alone and may be anxious in social situations.

4. **Agreeableness entails being compassionate and cooperative towards others.** Those who score high on agreeableness tend to get along well with people and are more sympathetic and caring. Those who score lower on this trait can be less empathetic and seem uninterested in others.

5. **Neuroticism refers to emotional sensitivity-particularly when it comes to environmental or situational factors.** Those who score high for this trait can be easily stressed and sometimes come off as worry-warts. Those who score low on neuroticism, on the other hand, tend to be more emotionally grounded and laid-back.

9.2 LOOKING INTO PERSONALITY DIFFERENCES

There are three dimensions of personality: 1) extraversion-introversion, 2) emotional stability-neuroticism, and **3**) psychoticism.

9.2.1 Neuroticism

Neuroticism, in psychology and development, a broad personality trait dimension representing the degree to which a person experiences the world as distressing, threatening, and unsafe. Each individual can be positioned somewhere on this personality dimension between extreme poles: perfect emotional stability versus complete emotional chaos. Highly neurotic individuals tend to be labile (that is, subject to frequently changing emotions), anxious, tense, and withdrawn. Individuals who are low in neuroticism tend to be content, confident, and stable. The latter report fewer physical and psychological problems and less stress than do highly neurotic individuals.

Neuroticism is associated with distress and dissatisfaction. Neurotic individuals (that is, those who are high on the neuroticism dimension) tend to feel dissatisfied with themselves and their lives. They are more likely to report minor health problems and to feel general discomfort in a wide range of situations. Neurotic individuals are more prone to negative emotions (such as anxiety, depression, anger, and guilt). Empirical studies suggest that extremely high levels of neuroticism are associated with prolonged and pervasive misery in both the neurotic individuals and those close to them.

Highly neurotic individuals are defensive pessimists. They experience the world as unsafe and use fundamentally different strategies in dealing with distress than non-neurotic people do. They are vigilant against potential harm in their environment and constantly scan the environment for evidence of potential harm. They may withdraw from reality and engage in protective behaviors when they detect danger.

Psychologists note that highly neurotic individuals tend to be poor problem solvers. Because of their tendency to withdraw, highly neurotic individuals tend to possess an impoverished repertoire of behavioral alternatives for addressing the demands of reality. Consequently, they tend to engage in mental role-play (rumination and fantasy) instead of constructive problem-solving behaviors. In contrast to their impoverished behavioral repertoires, however, they may possess a rich inner world. Introspective and apt to analyze their thoughts and feelings, they are highly invested in seeking the true nature of their intrapsychic experiences. Some neurotic individuals who have developed creative channels through which to tap their rich, overpopulated intrapsychic worlds, such as American filmmaker Woody Allen, have become successful artists.

Although high neuroticism is related to a deflated sense of well-being, high levels of neuroticism are not always associated with unfavorable characteristics. Neurotic behaviors may be essential for survival by facilitating safety through the inhibition of risky behaviors. Neurotic individuals tend to possess high anticipatory apprehension that may orient them to pay closer attention to contingencies previously associated with punishments. Also, the subjective discomfort (that is, anxiety) regarding violations of social convention may be greater in a neurotic individual than in others; thus, it may be less likely that a neurotic individual will become involved in some types of antisocial activity. There is some disagreement on this point, however, and some studies suggest that neuroticism may be linked to antisocial behavior. Some studies note that adolescents with extremely low neuroticism have been shown to possess a higher risk of adult criminality and to experience low levels of uncomfortable physiological arousal over violations of social conventions, whereas others suggest a positive correlation between neuroticism and some antisocial behaviors, such as substance abuse.

Keenly attuned to their inner experiences, those high in neuroticism are also attentive to their physical discomforts. Their health maintenance behaviors (that is, consultations with a physician) are more frequent than those of individuals with less neuroticism. Although their complaints regarding health are more frequent, their objectively assessed health is not poorer than those low in neuroticism. To the contrary, the results of some studies have found that their general health is often better, noting that neurotic individuals are diagnosed with cancer less frequently. Researchers hypothesize that this finding is attributable to the early detection of potentially harmful symptoms resulting from frequent health maintenance behaviors. Universal agreement on this point remains elusive, however, with other studies reporting that the linkages between personality and cancer diagnosis are inconsistent.

9.2.2 Agreeableness

Agreeableness is a personality trait manifesting itself in individual behavioral characteristics that are perceived as kind, sympathetic, cooperative, warm, and considerate. In contemporary personality psychology, agreeableness is one of the five major dimensions of personality structure, reflecting individual differences in cooperation and social harmony.

People who score high on this dimension are empathetic and altruistic, while a low agreeableness score relates to selfish behavior and a lack of empathy. Those who score very low on agreeableness show signs of dark triad behavior such as manipulation and competing with others rather than cooperating.

Agreeableness is considered to be a superordinate trait, meaning that it is a grouping of personality sub-traits that cluster together statistically. The lower-level traits, or facets, grouped under agreeableness are: trust, straightforwardness, altruism, compliance, modesty, and tender-mindedness.

9.2.3 Conscientiousness

Conscientiousness is the personality trait of being careful, or diligent. Conscientiousness implies a desire to do a task well, and to take obligations to others seriously. Conscientious people tend to be efficient and organized as opposed to easy-going and disorderly. They exhibit a tendency to show self-discipline, act dutifully, and aim for achievement; they display planned rather than spontaneous behavior; and they are generally dependable. It is manifested in characteristic behaviors such as being neat, and systematic; also including such elements as carefulness, thoroughness, and deliberation (the tendency to think carefully before acting).

Conscientiousness is one of the five traits of both the Five Factor Model and the HEXACO model of personality and is an aspect of what has traditionally been referred to as having character. Conscientious individuals are generally hard-working, and reliable. When taken to an extreme, they may also be "workaholics", perfectionists, and compulsive in their behavior. People who score low on conscientiousness tend to be laid back, less goal-oriented, and less driven by success; they also are more likely to engage in antisocial and criminal behavior.

Conscientiousness is one of the five major dimensions in the Big Five model (also called Five Factor Model) of personality, which also consists of extraversion, neuroticism, openness to experience, and agreeableness (OCEAN acronym). Two of many personality tests that assess these traits are Costa and McCrae's NEO PI-R and Goldberg's NEO-IPIP.[5] According to these models, conscientiousness is considered to be a continuous dimension of personality, rather than a categorical 'type' of person.

In the NEO framework, Conscientiousness is seen as having six facets: Competence, Order, Dutifulness, Achievement Striving, Self-Discipline, and Deliberation. Other models suggest a smaller set of two "aspects": orderliness and industriousness form an intermediate level of organization, with orderliness associated with the desire to keep things organized and tidy and industriousness being more associated with productivity and work ethic.

Other personality traits ((Low) extraversion, (high) agreeableness, (low) openness and (low) neuroticism) are linked to high conscientiousness along with impulse control. Behaviorally, low conscientiousness is associated with an inability to motivate one's self to perform tasks that the individual desires to accomplish.

Conscientiousness also appears in other models of personality, such as Cloninger's Temperament and Character Inventory, in which it is related to both self-directedness and persistence. It also includes the specific traits of rule consciousness and perfectionism in Cattell's 16 PF model. It is negatively associated with impulsive sensation-seeking in Zuckerman's alternative five model. Traits associated with conscientiousness are frequently assessed by self-report integrity tests given by various corporations to prospective employees.

9.3 PERSONALITY CHANGES

Your personality can gradually change throughout your life. Fluctuations in mood from time to time are normal. However, unusual personality changes may be a sign of a medical or mental disorder.

A personality change can be demonstrated in a variety of ways.

For example, a behavior that’s inconsistent with how you would typically react under said circumstances indicates a personality change.

A person behaving in an uncharacteristically moody, aggressive, or euphoric manner, inconsistent with their usual way of behaving in similar situations also demonstrates a personality change.

Being nonchalant in situations that would normally cause stress or aggravation is an example of a personality change.

Another example is being happy to hear tragic news.

While a gradual personality change isn’t unusual, a sudden change can be caused by an injury or illness.

Look for the following signs to determine if strange or unusual behavior is an emergency situation:

- weak pulse
- clammy skin
- rapid heart rate
- rapid breathing
- shallow breathing
- low blood pressure
- confusion
- dizziness
- light-headedness
- difficulty talking
- shooting pains in the arms or legs
- pain in the chest
- visual changes

If you or someone else experiences any of these symptoms, seek medical attention immediately.

9.4 NEW FOUNDATIONS FOR SEGMENTATION

Several recent happenstances are transforming marketing. For one, the unprecedented explosion of data being created by consumers, businesses, and governments offers immeasurable value for organizations that use data to understand customer behavior, current trends and coming events.

At the same time, online technology is empowering consumers to easily find the lowest-cost vendors, avoid ads that don't interest them and influence purchase behavior of tens of millions of people via online reviews, tweets and blogs.

Marketers need analytics to turn these mountains of data into insights and opportunities which will allow them to successfully connect with customers. An effective analytical framework helps marketers make smarter decisions as they execute strategies and plans, and enables analytically driven customer segmentation.

Analytically-Driven Segmentation

Customer segmentation is the process of dividing a buyer base into groups of individuals who are similar in specific ways relevant to marketing. There are two basic types of segmentation: foundation segmentation and targeting segmentation.

Foundation segmentation creates core, top-level segments that enable a company to deliver consistent treatment, and to focus on long-term strategy. Key attributes of foundation segments could include demographics, attrition risk, profitability, etc. All customers are included in such a segmenting process, and each belongs to only one segment. These segments can be subdivided into natural clusters, such as geography or level of profitability.

Foundation segmentation can be used for situations where no targeting segmentation exists, such as the introduction of a new product.

Targeting segmentation identifies customers with specific needs and preferences. Not all customers are necessarily included in targeting segments. Additionally, a given individual may fall into many different segments.

This type of segmentation is useful for specific marketing programs and campaigns. For example, targeting segmentation could identify customers most likely to respond positively to a one-off campaign, or those most likely to leave for a competitor. Attributes might include behavior, time periods, account status or product usage. The focus is short-term marketing activities, not long-term relationship building.

Analytics can be helpful in foundation segmentation, but they are imperative for targeting segmentation. In fact, analytics are the key to evolving beyond foundation segmentation to targeting segmentation.

Consider how a typical telecommunications company might use analytically-driven targeting. Say marketing defines as a primary target group the top 20 percent of the most profitable customers. Assume this group has the additional characteristics of high usage and high churn rate. Marketing might subdivide the group into three distinctive clusters based on two different revenue dimensions: usage revenue, which is generated from per-minute charges, and access revenue, which is gained from rate plans.

Marketing now has three distinct customer groups to further analyze and target with unique offers. Let's say that, of the three clusters, the high-usage revenue cluster shows the greatest profit per user, the lowest number of subscribers per account, and the middle churn rate. Marketers would use this information to develop an offer that this cluster of customers would desire. For example:

Individuals within the high-usage revenue cluster could receive an offer for a new phone if they renew their contract.

Those in the high-access revenue cluster could receive an offer for a 10 percent discount on their first month's fee if they renew their contract.

The cluster in the middle could receive an offer for 100 free minutes if they renew their contract.

Because these offers target the specific usage pattern for each cluster, they should be more attractive and generate higher response and revenue rates than those based on non-analytical segmentation strategies.

Expedia.com shows the way

Expedia.com provides a real-world example of applying analytics for targeting segmentation. Expedia.com leverages analytics to isolate customer segment groups based entirely on customer purchasing behavior. One surprising finding was the large number of customers who turned out to be business travelers. This group's frequency of travel and the days and times they traveled better matched the established "business traveler group."

Further analysis showed this customer segment is much more interested in seeing a full range of options specific to their time needs than are leisure travelers. So, Expedia created offers tailored to appeal to its newly discovered customer profile.

When built correctly, analytically driven targeting segmentation delivers significant benefits, including the ability to channel efforts toward customers most likely to buy specific products or services. It also helps identify an organization's most and least profitable customers. Marketers can also and avoid markets that won't be profitable, as well charge higher prices in markets that will bear it.

9.5 NEUROSCIENCE AND SEGMENTATION

Segmentation is the physical characteristic by which the human body is divided into repeating subunits called segments arranged along a longitudinal axis. In humans, the segmentation characteristic observed in the nervous system is of biological and evolutionary significance. Segmentation is a crucial developmental process involved in the patterning and segregation of groups of cells with different features, generating regional properties for such cell groups and organizing them both within the tissues as well as along the embryonic axis.

Human nervous system consists of the central nervous system (CNS), which comprises the brain and spinal cord, and the peripheral nervous system (PNS) comprising the nerve fibres that branch off from the spinal cord to all parts of the body. Both parts of the nervous system are actively involved in communicating signals between various parts of the body to ensure the smooth and efficient transfer of information that controls and coordinates the movement of muscles, and regulates organ functions. Neurons, which form the elemental unit of the nervous system, receive messages from their dendrites, relay the information as an electrical signal down the axon and releases chemical messengers known as neurotransmitters, thus converting the electrical signal into a chemical signal.

Segmentation is a crucial patterning process that is involved in the development of both the central nervous system and peripheral nervous system. In the central nervous system, segmentation is involved in the patterning of the neuronal population. Added to that, segmentation guides the developing axons and contribute to the development of the peripheral nervous system. In bilateral animals, the fundamental body plan involves the left and right sides as mirror images to each other with a hollow tube of gut cavity from mouth to anus along with a nerve cord with a structure named ganglion for each segment of the body. In fact, most evolutionary evidences point to the postulate that segmentation is an independent evolutionary event that arose multiple times and that the cellular and molecular pathways of segmentation might show differences in different contexts due to this fact.

The nervous system segmentation confers several developmental advantages to the vertebrate body as humans possess a body plan that is bilaterally segmented at the nervous system level. The segmentation is involved at all levels of the human nervous system with increasing level of complexity in the innervation from the brain to limbs. The presence of conserved features in various species of animals serves as a strong point to the nervous system's origin from a common ancestor. Also, the neural segments form the basic building block of the human nervous system and these sub units possess their own level of autonomy in both the singular and collective sense. The segments that compose the nervous system, although initially similar in their composition, are later modified by gene expression patterns that are specific to them. Segmental pattern in human beings can be observed clearly during early developmental phase.

9.5.1 New Knowledge to Support Gender Classifications

The following are some gender identities and their definitions.

Agender

A person who is agender does not identify with any particular gender, or they may have no gender at all.

Other terms for this may include:

- neutral gender
- null-gender
- genderless
- neutrois

Androgyne

A person who identifies as androgyne has a gender that is either both masculine and feminine or between masculine and feminine.

Bigender

A person who identifies as bigender has two genders.

People who are bigender often display cultural masculine and feminine roles.

Butch

Women, especially lesbians, tend to use this term to describe the way they express masculinity, or what society defines as masculinity.

However, the LGBTQIA Resource Center state that "butch" can also be a gender identity in itself.

Cisgender

A cisgender person identifies with the sex that they were assigned at birth.

For example, a cisgender woman is someone who still identifies with the sex — female, in this case — a doctor assigned them at birth.

Gender expansive

The LGBTQIA Resource Center define gender expansive as an "umbrella term used for individuals who broaden their own culture's commonly held definitions of gender, including expectations for its expression, identities, roles, and/or other perceived gender norms."

Those who are gender expansive include people who are transgender and people whose gender broadens the surrounding society's notion of what gender is.

Genderfluid

A person who identifies as genderfluid has a gender identity and presentation that shifts between, or shifts outside of, society's expectations of gender.

Gender outlaw

A person who identifies as a gender outlaw refuses to allow society's definition of "male" or "female" to define them.

Genderqueer

A person who identifies as genderqueer has a gender identity or expression that is not the same as society's expectations for their assigned sex or assumed gender.

Genderqueer can also refer to a person who identifies outside of how society defines gender or someone who identifies with a combination of genders.

Masculine of center

A person who uses this term is usually a lesbian or a trans person who leans more toward masculine performances and experiences of gender.

Nonbinary

A person who identifies as nonbinary does not experience gender within the gender binary.

People who are nonbinary may also experience overlap with different gender expressions, such as being gender non-conforming.

Omnigender

A person who identifies as omnigender experiences and possesses all genders.

Polygender and pangender

People who identify as polygender or pangender experience and display parts of multiple genders.

Transgender

This is an umbrella term that encompasses all people who experience and identify with a different gender than that which their assigned sex at birth would suggest.

Although most people think of trans men and trans women when hearing the word transgender, this term also encompasses people who identify as a gender other than man or woman, including nonbinary and genderfluid.

Trans

Trans is a more inclusive term that covers those who identify as nonbinary and those who are genderless, according to the LGBTQIA Resource Center.

Two Spirit

Two Spirit is an umbrella term that encompasses different sexualities and genders in Indigenous Native American communities.

There are many different definitions of Two Spirit, and Indigenous Native American people may or may not use this term to describe their experiences and feelings of masculinity and femininity.

This is a cultural term that is reserved for those who identify as an Indigenous Native American.

9.5.2 Segmentation by Age-Elderly

Market segmentation by age is one of the most important types of market segmentation due to the great difference between the needs and tastes of different age groups.

Market segmentation by age refers to the segmentation of potential customers according to the age factor. To further focus the company's resources on a specific market segment. This makes targeting customers easier and more effective.

Age is the most important factor in the market segmentation process (as a segmentation variable).

Therefore, it is essential to take into account the age factor in segmenting the market. Even for a company that chooses another segment factor such as geography or gender, for the following reasons:

1. Age often divides clients into groups with different behaviors and different requirements, unlike other factors. For example, providing a product or service in one geographic region may not differ from another. But as for the age factor, it is completely different.

2. Taking the age factor alone or adding to any other factor in dividing the market greatly facilitates administrative and technical work for you.

For example, if your products can be offered to children and adults, It is a big mistake not to take the age factor into consideration. Because the method of providing and marketing the service is completely different for each age group. In the children segment, you need a different team for production and marketing than you need for an adult.

3. Age does not only reflect the biological growth of humans. It reflects other important variables and characteristics that must be taken into account in the marketing and production process.

For example, age means that this age group is raised with similar experiences in various fields. They often listen to the same style of music and watch a certain type of TV programs and movies. So they share the same characteristics and thought processes. So the teen generation in the 1990s is not the same as the teen generation in the 2000s, they act completely separately

4. The age groups in each generation differ from the other generation in their purchasing habits and how they respond to advertisements. For example, the generation of 2000 tends to spend most of their time on Facebook, while the same age group in the previous generation tends to check their email frequently.

The market can be divided by age into several different groups. These groups reflect the customer (human) life cycle in general. For example, infants, children, teens, adults, middle-aged and elderly people.

If your product or service can be used by different age groups, you should start with segmenting the market by age

The method and steps involved in segmenting the market by age are not different from the steps for market segmentation in general

9.5.3 Youth Market

"Youth Marketing" is a term used in the marketing and advertising industry to describe activities to communicate with young people, typically in the age range of 11 to 35. More specifically, there is the teen marketing, targeting people age 11 to 17, college marketing, targeting college-age consumers, typically ages 18 to 24, young adult marketing, targeting youngsters use professionals, typically ages 25 to 34.

The youth market is critical because of the demographic's buying power and its members' influence on the spending of family members. In addition, teens and young adults often set trends that are adopted by other demographic groups.

While frowned upon for teens and young adults, another common way advertisers target the older youth market is through product placement, which occurs when a brand name product appears in a medium not necessarily related to the product itself. Companies often pay for their products to be placed in a movie or on a television show. This act, while not an overt form of advertising, seeks to target teens and children in a subtle manner.

Youth marketing strategies commonly include television advertising, magazine advertising and online marketing. Today young people expect to be able to learn about, interact and be entertained with brands or services targeting them online. Other common youth marketing tactics include entertainment marketing, music marketing, sports marketing, event marketing, viral marketing, school and college programs, product sampling and influencer marketing.

Examples of brands embraced by youth and used as examples in marketing cases are Vans Footwear, which used youth marketing tactics to grow from a niche skateboard shoe brand to a successful international business, and Mountain Dew, a well-known soft drink brand that expanded market share through youth marketing tactics in the 1990s.

9.6 NEURAL CONDITIONINGS OF BUYING

The decision whether to purchase a product is the fundamental unit of economic analysis. From the bazaar to the Internet, people typically consider characteristics of available products, determine their cost, and then decide whether or not to purchase. The success of economic theory rests on its ability to characterize this repeated and elementary decision process. Neuroeconomic methods offer the hope of separating and characterizing distinct components of the purchase decision process in individual consumers.

In addition to being attracted to preferred products, consumers avoid prices that seem excessive. Many incentive schemes for promoting purchasing appear designed to diminish the salience of payments (e.g., credit cards), or to create the illusion that products have no cost (e.g., frequent flyer mileage). To explain these phenomena, recent behavioral economic theories have postulated a hedonic competition between the immediate pleasure of acquisition and an equally immediate pain of paying. The notion that peoples consider prices as a potential loss can be contrasted with a different economic account in which people represent prices as potential gains of alternative products that could be purchased for the same amount of money.

The idea that purchases decisions involve a tradeoff between the potential pleasure of acquisition and the pain of paying is consistent, however, with recent neuroscientific evidence that distinct neural circuits related to anticipatory affect provide critical input into subsequent decisions. Mounting neuroimaging evidence suggests that activity in different neural circuits correlates with positive and negative anticipatory affect. In the absence of choice, anticipation of financial gains activates the nucleus accumbens (NAcc) and correlates with self-reported positive arousal, whereas gain outcomes activate the mesial prefrontal cortex (MPFC). These findings have been interpreted to indicate that NAcc activation correlates with gain prediction, while MPFC activation correlates with gain prediction errors. Further findings suggest that anticipation of physical pain activates the insula among other areas, and insula activation also correlates with self-reported negative arousal. Thus, insula activation has been hypothesized to play a critical role in loss prediction. Emerging evidence also suggests that activation in these circuits may influence subsequent choice. For instance, during an investing task involving choice of risky (e.g., stocks) or riskless (e.g., a bond) alternatives, NAcc activation preceded switching to risk seeking strategies (in which anticipated gain should outweigh anticipated loss), while insula activation preceded switching to risk-averse strategies (in which anticipated loss should outweigh anticipated gain).

Compared to choices involving purely financial risks, purchasing of products represents a less constrained decision scenario, because products can potentially vary along infinite dimensions. However, decisions to purchase may recruit common anticipatory affective mechanisms. For instance, a growing number of FMRI studies have explored neural correlates of product preference. Specifically, men who view pictures of sports cars versus less desirable types of cars show increased mesolimbic activation (midbrain, NAcc, MPFC). Both men and women who view pictures of preferred versus nonpreferred drinks show increased MPFC activation. Both men and women who taste preferred versus nonpreferred drinks also show greater MPFC activation. Finally, men who view pictures of preferred versus nonpreferred brands of beer show increased MPFC activation, and women who view pictures of preferred versus nonpreferred brands of coffee also show increased MPFC activation. Together, these findings implicate mesolimbic dopamine projections areas in the representation of anticipated gain, but do not clarify different roles of these distinct projection areas. Additionally, subjects did not actually purchase products in any of these studies. Preference may lead to purchasing, but only when the price is right.

The goal of this study was to determine whether distinct neural circuits respond to product preference versus excessive prices, and to explore whether anticipatory activation extracted from these regions could independently predict subsequent decisions to purchase. Subjects were scanned while engaging in a novel SHOP (i.e., “Save Holdings or Purchase”) task, which consisted of a series of trials of identical temporal structure, in which subjects could purchase products. Subjects saw a labeled product (4 s), saw the product’s price (4 s), and then choose either to purchase the product or not (by selecting either “yes” or “no” presented randomly on the right or left side of the screen; 4 s), before fixating on a crosshair (2 s) prior to the onset of the next trial. Timing for each trial period was intentionally limited to minimize distractions and maximize affective engagement in the task. We predicted that during product consideration, preference would activate neural circuits associated with anticipated gain. We also predicted that during price presentation, excessive prices would activate circuits associated with anticipated loss, as well as deactivate brain regions previously associated with balancing potential gains against losses. Finally, we predicted that activation extracted from these regions prior to the purchase decision would predict whether individuals would subsequently choose to purchase a product, above and beyond self-report variables. Thus, this work represents the first attempt to distinguish neural correlates of consumer reactions to preference versus price information, and also to use brain activation to predict purchasing.

9.6.1 Consumers with Depression and Mood Disorders

This study summarizes the emotional, cognitive, and behavioral aspects of mania/depression and cyclothymia, a milder form of the syndrome. Column 1 lists the conditions along the manic-depressive continuum ranging from pronounced clinical states that require institutionalization to moderate and mild manifestations that blend imperceptibly into normal behavior. Column 2 lists the emotional concomitants of each state. It reflects the American Psychiatric Association classification of these conditions as affective disorders Emotional triggers that drive cognitive and behavioral responses important to consumer behavior. Column 3 lists the cognitive concomitants. Column 4 lists the consumption effects associated with the continuum of mania and depression. Note that some of these effects are among the diagnostic criteria set forth by the American Psychiatric Association. Let us begin with a discussion of the emotional aspects of the continuum.

Clinical Mania: The high end of the continuum is the state of clinical mania, which manifests itself as extreme euphoria unconnected to any real-world event. It is often accompanied by disrupted cognition, with the manic individual exhibiting grandiose delusions such as viewing him/herself as God or royalty, claiming prophetic powers, or insisting that supernatural beings communicate with him/her. Ordinarily this state requires institutionalization, but nowadays this is often temporary. That is, patients can be stabilized and then deinstitutionalized, rather than locked out of society indefinitely.

Hypomania: The category of affect milder than clinical mania is termed hypomania, a state of low-to-mild mania that is considered quite pleasant by many persons who experience it. Consumers in this state feel buoyant, happy, and are filled with self-confidence. They are gregarious and sociable, often seeking out people with whom to interact. Their good humor, wit, and charm attracts people, and they may be charismatic leaders. In terms of consumption traits, hypomanic people demonstrate boldness, venturesomeness, and the urge to explore, which energizes the risk-taking attitudes associated with innovativeness and novelty-seeking.

Typically, hypomania is accompanied by intensified sensory and aesthetic responsiveness in which colors, sounds, smells, tastes, and textures are experienced in a heightened way as exceptionally vivid and pleasurable. In contrast, as we discuss below, the depressive emotional range is characterized by decreased responsiveness to external sensory stimulation, with internal mood states blocking positive responses to hedonic and aesthetic pleasure.

Depression: Below the mid-point of the continuum is the range of emotions identified as "depressed," including irritability, anxiety, self-doubt, lethargy, and social withdrawal. At the extreme of clinical depression, individuals may feel so profound a sense of hopelessness that they think about committing suicide. Just as hypomania has profound implications for consumer behavior, so too does mild-to-moderate depression.

9.6.2 AD/HD Cluster

The core symptom clusters of ADHDs, defined as inattention, hyperactivity and impulsivity, are associated with problems remaining focused in a task and for prolonged periods, as well as difficulties in organizing activities, prioritizing tasks and time management. Adults with ADHD will often report that tasks are finished just at deadline, or not at all, that bills are not paid and letters not answered. Impulsivity in adults may have other and more serious consequences than during childhood, such as reckless driving, terminating valued relationships or quitting jobs without having any alternative. The aimless restlessness and increased activity of childhood may change to become more adaptive and purposeful in adults, and in some adults the restlessness may be felt rather than manifested in overt behaviour.

9.7 FROM DEFICIENCIES TO SEGMENTATION

Since the introduction of the market segmentation concept, a wide variety of approaches to segmenting markets have been proposed. Researcher suggested that these various approaches could be classified into two major types: "empirical stream", based on characteristics of buyers or users, and "product stream", based on characteristics of the product or service itself, or on usage rates or patterns, or on important product attributes, or on situations or occasions of use. In a later review article, Researcher used different terms in referring to this same dichotomy: "general customer characteristics" (for empirical stream) and "situation-specific customer characteristics" (for product stream).

This paper will present a new form of product stream segmentation that is based on perceived deficiencies in product/service attributes. Earlier work in attribute-related segmentation has focused on the relative importance of key attributes, in order to identify those the consumer wants most. But as researcher point out, "Knowing what the customer wants isn't too helpful if a dozen other companies are already serving the same customer's wants". This suggests that a more useful approach than simply measuring attribute importance might be to measure directly the extent of unmet needs in the most important product attributes. We will call these unmet needs "deficiencies". If these deficiencies can be measured at the individual level, consumers can be segmented into groups that have homogeneous patterns of attribute deficiencies. The resulting groups can be referred to as "deficiency segments". Marketing strategies aimed at reducing or eliminating sizeable deficiencies in important attributes for a target deficiency segment could be expected to have a meaningful impact on product/service/brand preference as well as purchase.

Measuring Attribute Deficiencies

Researchers have used several approaches to measuring deficiencies in product/service attributes. Those most frequently used can be classified into one of three types: expectancy confirmation (EC), ideal point (IP), and value-percept disparity (VPD).

1. Expectancy Confirmation

Research on consumer satisfaction/dissatisfaction (CS/D) has been dominated by the measurement of discrepancies between consumer expectations and the perceived performances of a product/service. Some studies have measured these discrepancies at the level of overall or total performance only, while others have looked at several component attributes or features in addition.

Researchers have used a variety of approaches to measure expectancy confirmation at the specific attribute level. Researcher distinguish between inferred and perceived disconfirmation. Inferred disconfirmation is measured by asking buyers prior to usage to rate the level of each attribute they expect the product/service to have, and then to rate attribute performance after usage. The difference between before and after ratings constitutes inferred disconfirmation. In contrast, perceived disconfirmation obtains both of these measurements after product usage and therefore respondents are asked to recall their anticipated levels of attribute performance. To address some conceptual problems with these approaches, Researcher used "better than expected worse than expected" scales as measures of satisfaction and other post-exposure cognitions. Of course, some investigators have used only post-usage measures of satisfaction, but these do not offer any deficiency or discrepancy measures and therefore are not useful for purposes of the present study.

Regardless of how they are measured, discrepancies between expected and observed performance at the attribute level can be used as inputs to clustering programs that identify relatively homogeneous groups of respondents based on their patterns of discrepancies.

9.8 THE PERSONALITY CONNECTION

Ever since the affective and cognitive neurosciences have embarked on their journey towards unraveling the biological basis of cognition, motivation/emotion, and behavior, new technologies and paradigms have shaped their path. One of the hallmark developments on the technological side was MRI. It enables researchers to non-invasively assess neural processes in the awake human brain. MRI is not perfect, just like any other scientific method, but it is of indisputable value for the study of the human brain. On the spatial level, MRI depicts anatomy of the living human brain with unprecedented spatial detail. On the functional level, it can keep track of ongoing activity in brain dynamics. Furthermore, MRI has been approved for use in healthy human research participants who volunteer their time for scientific enquiry. In this regard it is superior to other techniques like intracranial recordings, optogenetic imaging, or radioligand-based imaging which are either not approved for the use in healthy human volunteers, are not approved for use in humans at all, or are severely constrained due to the emission of harmful radiation. Since its introduction in the early 1990s, MRI has positioned itself as the methodological backbone of cognitive neuroscience and has provided marvelous insights into the neural foundation of psychological processes.

On the paradigmatic side, the last 10 years have seen the rise of connectomics and network neuroscience as a new way to reason about the brain. The neologism connectome, introduced independently by Patric Hagmann and Olaf Spons in 2005, combines the term “connection” with the suffix “-ome” which stands for “the whole class of something.” In analogy to the term genome (“gene” and “ome”) which describes the entirety of and the organizational principle behind the genetic information of a species or an organism, a connectome describes the organization of connections throughout a nervous system. The brain is a complex network whose intricacy can be apprehended on many different resolution levels. On a microscopic level, neurons sprout axons that find their way to the dense dendritic trees of other neurons where they connect via synaptic contacts. On a macroscopic level, the axons of thousands of neurons merge together in major white matter fiber bundles that project from one brain area to another. MRI technology can be applied to non-invasively map these fiber bundles in the human brain and to estimate from functional imaging data how information processing unfolds along these pathways. MRI connectomics has revealed that neural connections follow—despite all their complexity—certain organizational principles that enable efficient and goal-oriented information processing. Recent years have seen major advances in the field of network science. Sophisticated network modeling tools have been developed that are increasingly applied to brain connectivity data in order to unravel organizational principles and understand their relevance for psychological processes and clinical conditions.

Personality neuroscience as a new field of study within the cognitive and affective neurosciences has embraced neuroimaging, psycho-pharmacology, molecular genetics, and psychophysiological methods as its tools of choice to study the biological foundations of personality, and to derive explanatory models of individual differences. In the present contribution, we argue that neural network modeling techniques should step up to join the methodological pantheon of our field. We will outline how connectivity research can complement more traditional brain mapping approaches such as brain activation or simple morphological studies in assessing the biological bases of personality traits. To this end, we are going to introduce key concepts and findings of resting-state functional MRI (fMRI), diffusion MRI and basic ideas of network neuroscience, with the aim of promoting the application of network neuroscience in general, and MRI-based connect omics in particular, to the study of personality and as a basis of new types of personality theory. We will build our arguments mostly on studies investigating non-ability traits, even though similar ideas should in principle be also applicable to other aspects of individual differences.

9.9 BUYING STYLES

1. Buying Style 1 – The Decisive (D Style)

The four buying styles are based on the DISC behavioral model, and they control how we like to communicate and be communicated with, how we prefer to make purchasing decisions, and the speed with which we prefer to make them.

The first buying style is called the Decisive. These buyers have a clear picture in their mind of what results they want. They are often seen as "Type-A" people, preferring to make buying decisions very quickly. They are more often interested in "winning" or "promoting their own agenda" so they like to buy when they feel they have "gotten their way," so to speak. They are attentive to actions or communication that will speed up those results. Discussions about details and minutiae are distracting to these individuals. They prefer to discuss top-line, big-picture concepts when considering the value of any offering.

Selling to Decisive buyer (looking for results and efficiency):

- Be practical and efficient (avoid theory)
- Highlight opportunities for change and adventure
- Avoid overly emotional discussions or opinion-based arguments
- Accentuate independence and competition
- Challenge their idea, perhaps, but not them personally
- Stick to the big-picture, bottom-line business at hand
- Be quick and to the point (do not waste their time)
- Likes new, innovative things
- Let them be in control

Decisive buyers are Innovators = they will buy unproven, brand new, cutting-edge solutions that have not been proven by anyone else in the market. They revel in the chance to be the first to try things. Sales key = Let them lead…NOW!

The odds of running into a Decisive buyer are 10-15% in the general public.

On connection and speed:

When connecting with Decisive buyers don't try to connect very much. This buying style prefers more professional relationships, may distrust you if you start asking all kinds of questions about their family and seek to become their new best friend. Coming on too personally is to be avoided with this style.

Regarding pace, when dealing with Decisive buyers you can move quickly and have a shorter sales cycle. They don't require as much evidence; are prone to making rash decisions with less rational thought and more instinct, or gut intuition. Be aware that if you take too long in your sales cycle, you will hurt your chances of closing the sale. Decisive buyers don't like to take too long to make a decision, and hate getting caught up in the details.

2. Buying Style 2 – The Interactive (I Style)

The second buying style is called the Interactive. These buyers want to shape and mold events and enjoy “getting their way” when it comes to negotiations or buying something. Unlike the High D, however, High I’s tend to go about this by working with or through people – much more collaboratively. They are interested in people and like to interact with others, understand others and to be understood by others. They are most receptive to making a buying decision when they feel a sense of connection with the person, are in a more social environment and have had the opportunity to express their emotions, thoughts, fears or excitement about the offering first. Like the High D, this person is also particularly inattentive to details, preferring to stick to the big-picture and emotional benefits of the solution.

Selling to Interactive buyer (looking for interaction and an experience):

- Avoid challenging them or personal conflict
- Don’t aggressively close or push
- Be enthusiastic and express emotions
- Let them talk!
- Highlight potential improved appearance, social standing, approval by others
- Have fun!
- Accentuate the “newness” factor
- Name dropping is not a bad thing here (if done tastefully, of course)

Interactive buyers are Early Adopters = almost as brazen as the Decisive buyer, but they really appreciate social proof as well. Be sure to point out how your solution allows them to “join others” who are leading the way, pushing the boundaries and blazing new trails. Sales key = Listen twice as much as you talk!

The odds of running into an Interactive buyer are 25-35% in the general public.

On connection and speed: When connecting with Interactive buyers you can connect more. Actually, doing so will improve your chances of signing their business. Not doing so will hurt those chances. Regarding pace, when dealing with Interactive buyers you can move quickly and have a shorter sales cycle. They don't require as much evidence; are prone to making rash decisions with less rational thought and more instinct, or gut intuition. Be aware that if you take too long in your sales cycle, you will hurt your chances of closing the sale. Also, Interactive buyers hate getting caught up in the details.

3. Buying Style 3 – The Stabilizer (S style)

The third buying style is called **the Stabilizer**. These buyers are more passive and introverted and interested in the how and why of a solution (i.e., the details and minutiae that the I and D couldn't care less about). Their primary interests are in maintaining stability within themselves and whatever situation they find themselves in. Messages that don't address the specifics, or that champion radical change, are likely to alienate rather than resonate. They prefer to buy things that will increase the stability in their lives, provide more security, and are well known and well proven. They prefer to "take their time" more than any other dimension so any offering should give them plenty of time to decide.

Selling to Stabilizer buyer (looking for security and stability):

- Avoid conflict (with them or trashing anyone else, even those not present)
- Reassure and reduce risk as much as possible
- Provide structure, step-by-step details and security
- Give them ample time to decide (as in days or weeks in some extreme cases)
- Accentuate your support and commitment long-term (think family)
- Be sincere, modest and unassuming
- Don't get too personal too fast

Stabilizer buyers are Early to Late Majority buyers = not wanting to be on the front lines like the high D's and I's, the Stabilizer buyer prefers to wait until they can be certain that the risk has been minimized, others have tried it first and they are joining the majority. Sales keys: slow and steady wins this race!

The odds of running into a Stabilizer buyer are 45-50% in the general public.

On connection and speed:

When connecting with Stabilizer buyers you can connect more. Actually, doing so will improve your chances of signing their business. Not doing so will hurt those chances. Regarding pace, Stabilizer buyers prefer to take it slow, not be rushed and get familiar with all the variables before making a decision. Push this buyer too fast and they will balk. You have to take it slowly and provide lots of security and certainty with this buyer.

4. Buying Style 4 – The Conscientious (C style)

The fourth and final buying style is called the Conscientious. These buyers are also more passive and introverted. Like the High S, they too take a much more detailed (the most) and accuracy-based approach to their buying habits. Their buying decisions are very much driven by questions of accuracy, detail, reliability, level of proof, etc. Without sufficient data to prove any statements made to a High C, you will fail to achieve their buy in. Why is a favorite question for a high C buyer. Prove it is the second most common one. They are very concerned with doing things accurately. They are receptive to offerings that provide proof that the solution works, proposals that are meticulously detailed and absent of ANY grammatical mistakes or typos.

Selling to the Conscientious buyer (looking for accuracy and information):

- Provide high levels of high-quality evidence and proof (data, facts, statistics, etc.)
- Connect to solving problems
- Make sure zero typos, grammatical mistakes or forgotten deliverables never happen
- Ensure accuracy, reliability and dependability
- Avoid pointing out any mistakes they may make

- Be organized and logical
- Be unemotional
- Establish trust, through proof

The Conscientious buyer is the Late Majority to Non-Adopter = if there is one style that may never adopt it is this one. They require the most proof, the most evidence and the most "selling to" before they have enough data to decide to buy. They require plenty of facts, data and proof. Sales Key = Data, Proof, Facts…with ZERO errors!

The odds of running into a Conscientious buyer are 20-30% in the general public.

On connection and speed:

When connecting with Conscientious buyers don't try to connect very much. This buying style prefers more professional relationships, may distrust you if you start asking all kinds of questions about their family and seek to become their new best friend. Coming on too personally is to be avoided with this style. Regarding pace, the Conscientious buyer likes a slower pace. They don't like to be rushed. They want plenty of time to consider the facts, analyze the options and study the data. Failing to provide this buyer with ample time to conduct their research or carefully weigh their options will push them away and ruin your chances of making a sale.

9.10 ON THE PRACTICALITY OF THE NEURO SEGMENTATION

Is segmentation based on how the mind works. In this segmentation, demographics and lifestyle are irrelevant. Instead, clusters are identified according to the brain's response to stimuli. Australian based company "Neuro Power" practices this segmentation, and groups according to 9 'Core Belief Profiles' (such as 'The Groupie' The Idealist and The Obsessive). Their methodology is largely based on Peter Burows 'Human Operating Systems' framework.

The early stages: Pepsi Challenge, 2004

An early example of the application of neuromarketing was in 2004 when Read Montague, Director of the Human Neuroimaging Lab at Baylor College of Medicine, decided to redo the Pepsi Challenge blind taste test – using brain imaging. 67 volunteers underwent the taste test while hooked up to brain scanning machines. Half reported a taste preference for Pepsi, when they didn't know what brands, they were drinking, while three-quarters said they preferred the taste of Coke when they were told it was Coke. Furthermore, during this second test, brain activity changed and was focused in the prefrontal cortex (associated with thinking and judging), and the hippocampus (the part of the brain related to memory) – suggesting that memories and other impressions about the Coke brand were influencing consumer perception of taste.

Revolutionary? Perhaps not, if you consider that conventional research methods have delivered similar results. A recent article by Jennifer E. Breneiser and Sarah N. Allen in the North American Journal of Psychology, gives a sound account of Cola blind tests since the 1940s. The most recent studies concluding that 'brand', and specifically the better-known brands such as Coke, do indeed change consumer taste preferences.

Neuromarketing vs Traditional means

Given that almost 90% of our decisions are made by our sub-conscious, neuromarketing presents an attractive alternative to interviews, focus groups and surveys. One of the leading practitioners, Californian based 'science-based consumer research' firm Neuro Focus (owned by Nielsen Holdings), claim that their specially designed electrode-studded cap can measure brain wave activity at the rate of 2,000 times per second, and in doing this, can read the subconscious responses to adverts or products in real time, and decipher the degree of emotional engagement, attention and cognition by monitoring the various parts of the brain.

The sales pitch has won over big brand clients including Google, Frito-Lay (Pepsi), PayPal, and Walt Disney – all of whom recognize the potential of neuromarketing to deliver results that are 'pure' and untainted by the biases inherent in traditional research. The cost and efficiency benefits are also appealing, with a minimum sample size of 20 at a cost of $US40,000 to $US50,000.

What we need to decipher then, is whether the sub-conscious mind always dominates the conscious mind when making purchase decisions? It is reported that PayPal used a conventional online survey in addition to Neuro Focus when deciding on their new corporate identity. The two methods showed discrepancies as to the benefits of the PayPal brand; according to Neurofocus, 'on my side' was the dominant benefit, whereas the surveys suggested this was a weak association. In cases like these, how do we reconcile such differences? Which method is to be believed as the true reflection of how consumers will respond in the market place?

As Chris Frith, Professor of Neuropsychology at the Institute of Neurology in London, says "People have the idea that because you are using big, expensive equipment it is more real than asking what people think. They think they've got an easy way to get the information they want — a short cut. But it is very important to consider the subjective measures. If we see from scans that someone is happy, but they say that they aren't, who do we believe?"

A balancing act

It seems somewhat misguided to ignore the control that the conscious mind exerts over our sub-conscious impulses. Not to mention the psychological, social and cultural aspects that effect consumer choice and purchase in the marketplace. For that reason, I am dubious about the benefits of neuromarketing used as a tool on its own. Perhaps used in conjunction with conventional research and marketing tools it could work to inform decisions around packaging, advertising and other promotional material, but I fail to see how brain reactions to very specific stimuli – words, images, advertisements – can provide a complete picture of the consumer's problems and needs and hence replace these tried and tested methods.

So while traditional methods of market research cannot dig deeper into the subconscious, products like NeuroFocus cannot measure the effect of the rational mind. As humans are such complex creatures, it would be beneficial for product managers to understand both. Neuromarketing could be used as a complement to traditional means – a way to fine tune product design, development and deployment once we know and understand our target market.

9.11 NEURO SEGMENTATION AND POSITIONING: META DIMENSIONS

Various approaches to automated segmentation of CT and MR images are widely used in research environments and promise to transform clinical practice. Radiologists involved in interpreting images in patients with cancer, obesity, cardiovascular disease, neurodegeneration, osteoporosis, arthritis, and many other conditions will benefit from these approaches as they help clinicians diagnose disease, determine prognosis, select patients for therapy, and follow responses to therapy. To enable this transition from research to patient care, radiologists should become familiar with various methods used for automated segmentation of CT and MR images.

Segmentation refers to identifying the boundaries of an object in the image. Frequently, the object is an organ, a tissue, a pathologic lesion, or another structure used for diagnosis or management of a particular disease. Traditional approaches to segmentation rely on manual or semi-automated delineation of the object of interest. While these approaches are effective, they are time-consuming and impractical for large scale research studies and even less practical for clinical practice. As a result, many fully automated approaches to tissue segmentation are being developed.

Automated segmentation methods using CT and MRI are generally built on basic image processing of pixel intensities and/or textural features (e.g., relationships between groups of pixels), and may incorporate advanced model-based, atlas-based, or machine learning (ML) techniques. Segmentation techniques can be broadly divided into supervised and unsupervised.

Supervised techniques require prior training that is most commonly performed manually. These methods typically include pre-processing such as intensity normalization (e.g., histogram-based, reference tissue), followed by classification (e.g., artificial neural networks, k-nearest neighbors, Bayesian, random decision forests), and feature selection based on intensity, spatial, texture, or contextual information. They are considered to be more accurate, but require expert annotation which is both expensive and time consuming.

Unsupervised segmentation techniques do not require any training and are generally considered less accurate than supervised techniques. These methods usually incorporate clustering (e.g., fuzzy c-means, expectation-maximization) and spatial information (e.g., Markov random fields, graph cut, anatomical/topological atlases) to segment the image. They also commonly rely on labeled atlases.

The reported performance of supervised and unsupervised segmentation techniques varies greatly, depending in part on the validation metrics used. Generally, the validation is based on the assessment by experts. Since evaluation by a single expert may be biased, some studies employ multiple experts using techniques such as Simultaneous Truth and Performance Level Estimation (STAPLE). In some cases, the segmentation techniques are validated against established pipelines, such as Free Surfer (https://surfer.nmr.mgh.harvard.edu/), SPM (https://www.fil.ion.ucl.ac.uk/spm/), or FSL (https://www.fmrib.ox.ac.uk/fsl). Another approach uses publically available "challenge databases" for training and validation of automated segmentation techniques.

Many validation metrics have been used for quantitative comparison between the automated segmentation results and ground truth. These metrics include: Dice similarity coefficient (DSC), Jaccard index, volume difference, Hausdorff distance, intraclass correlation, and Pearson's coefficient. The DSC calculates the overlap between two binary segmentation results by accounting for both the intersection and the union of the two results. More familiar metrics are also occasionally used, including: sensitivity, specificity, accuracy, positive predictive value, and negative predictive value.

Previous reviews of segmentation have focused on CT or MRI of a single body region, often combining semi-automated and automated approaches, and rarely using the methodologic rigor of a systematic review. There is a need for a systematic review that focuses on automated segmentation using CT and MRI of the entire body.

We provide such a systematic review of the automated segmentation methods and discuss how these methods have been used in neurologic, thoracic, abdominal, musculoskeletal, and breast imaging. Ultimately, we hope to prepare radiologists for eventual integration of these techniques into their clinical practice.

9.12 POSITIONING COMBINED BRANDS

Brand positioning has been defined by Kotler as "the act of designing the company's offering and image to occupy a distinctive place in the mind of the target market". In other words, brand positioning describes how a brand is different from its competitors and where, or how, it sits in customers' minds.

A brand positioning strategy, therefore, involves creating brand associations in customers' minds to make them perceive the brand in a specific way.

By shaping consumer preferences, brand positioning strategies are directly linked to consumer loyalty, consumer-based brand equity, and the willingness to purchase the brand. Effective brand positioning can be referred as the extent to which a brand is perceived as favourable, different and credible in consumers' minds.

How to find a powerful brand positioning (3 simple steps)?

Step 1: In order to create a unique and successful positioning for your brand, you need to analyze the following:

1. Understand what your consumers want
2. Understand what your company's and brand capabilities are
3. Understand how each competitor is positioning their brand

Step 2: Once you've done that, you will need to choose a positioning statement that:

1. Will resonate with your consumers
2. Can be delivered by your company (capabilities)
3. That is different from your competitors

An easy way to define a brand positioning statement is to summarize it in three words. For example, "vegan, traditional & feminine". Try not to choose generic words such as "quality-products, unique, successful" because this is the aim of every brand.

Step 3: The remaining challenge is to then reflect this brand positioning in everything that you do (brand personality, packaging design, product, service, visual identity design, communications, etc.).

Chapter 10

APPLYING NEUROSCIENCE AND BIOMETRICS TO THE PRACTICE OF MARKETING

10.1 APPLYING NEUROSCIENCE TO MARKETING DECISIONS

Neuromarketing is the application of neuroscience to marketing. Neuromarketing includes the direct use of brain imaging, scanning, or other brain activity measurement technology to measure a subject's response to specific products, packaging, advertising, or other marketing elements. In some cases, the brain responses measured by these techniques may not be consciously perceived by the subject; hence, this data may be more revealing than self-reporting on surveys, in focus groups, etc.

More generally, neuromarketing also includes the use of neuroscience research in marketing. For example, using fMRI or other techniques, researchers may find that a particular stimulus causes a consistent response in the brain of test subjects, and that this response is correlated with a desired behavior (e.g., trying something new). A marketing campaign that specifically incorporates that stimulus hoping to create that behavior can be said to incorporate neuromarketing, even though no physical testing of subjects was done for that campaign.

One of the challenges is that in some respects, ALL marketing is neuromarketing, since marketing campaigns are almost always trying to produce some kind of brain activity that will lead to a desired behaviour (e.g., buying a product). That's not a partially useful way to look at neuromarketing, though, in the same way that saying "everything is chemistry" (since all living and non-living things are made up of molecules) is true but not helpful. Hence, we exclude marketing efforts that don't specifically incorporate neuroscience research – either through new tests or by using the data from past work.

10.2 USING NEUROSCIENCE FOR THE SAKE OF ADVERTISING

It's been over a decade since the merging of neuroscience and marketing first began to take shape. At the time, companies like Bright house were using neuromarketing research and consulting services advocating the use of cognitive neuroscience research and consulting services. This, in turn, helped companies make better advertising choices, hone their messaging, and reach targeted groups of consumers.

The reptilian brain - the oldest part of our brain that controls the body's vital functions still controls our first reactions to stimuli and is somewhat rigid and compulsive versus newer parts of our brain – the limbic brain and neocortex brain. So essentially, the brain takes input from the other two brains but the reptilian brain controls the final decision-making process whether we like it or not!

The magic seems to have worked. Consider, for example, how well the HBO series Silicon Valley has mastered the art of subtle product placement. From the Red Bull cans that litter the table in Erlich's house/business "incubator" to his references to Fage yogurt to the fact that Pied Piper's rival firm Hooli is loosely modeled after Google, the number of parallels to real-world brands is virtually limitless. Good or bad, using the art of neuroscience - or, a targeting of the viewer's unconscious desires - proves that the show's producers clearly understand that everyday decisions are largely driven by subconscious and even unconscious emotional responses.

"People are fairly good at expressing what they want, what they like, or even how much they will pay for an item," said Uma R. Karmarkar, an assistant professor at Harvard Business School, in Harvard Business Review's What Neuroscience Tells Us About Consumer Desire. "But they aren't very good at accessing where that value comes from, or how and when it is influenced by factors like store displays or brands. Neuroscience can help us understand those hidden elements of the decision process."

A few of the neuroscience techniques include:

- **Acoustic encoding** – the process of remembering and comprehending something that you hear.

- **The Cheerleader Effect** or **Group Attractiveness Effect** – the cognitive bias which causes people to think individuals are more attractive when they are in a group.

- **Anchoring or focalise** - the tendency to rely too heavily, or "anchor," on one trait or piece of information when making decisions (usually the first piece of information that we acquire on that subject).

- **Peak–end rule** - that people seem to perceive not the sum of an experience but the average of how it was at its peak (e.g. pleasant or unpleasant) and how it ended.

- **Negativity bias - p**sychological phenomenon by which humans have a greater recall of unpleasant memories compared with positive memories.

- **Conjunction fallacy - t**he tendency to assume that specific conditions are more probable than general ones.

Silicon Valley's production team isn't alone in its quest to harness their viewers' subconscious brainwaves. In June, Nielsen Consumer Neuroscience introduced a new ad testing solution that the company expects to "set a new standard for marketers looking to elevate their advertising creative and optimize in-market performance." Video Ad Explorer integrates a suite of neuroscience technologies and "helps brands unlock consumer insights and unravel the complexities of advertising creative development with unprecedented predictive power," according to a Nielsen press release.

The fact that cable TV producers and industry leaders are betting on neuroscience isn't a big surprise. Marketers and agencies have been trying to figure out the connection between environmental cues and buying decisions for decades. In a 2003 study, for example, a professor of neuroscience set out to learn how our brains handle brand choices. Through this exercise he found that strong brand like Coca Cola could "own" a piece of our prefrontal cortex - the area of the brain that manages attention, controls short-term memory, and managed planning.

Fast-forward to 2016 and we now have the technology, platforms, applications, and analytics needed to tap into neuroscience in a very accurate and efficient manner. And in a world of ever-shrinking attention spans, where consumers skip around from screen-to-screen, it's no surprise that advertisers are turning to neuroscience to better understand how to engage consumers.

"People are not governed by the rational side of their brains, so the majority of purchase decisions are made irrationally," said Itiel Dror, a Harvard-trained neuroscientist, in Bloomberg's Marketers' Next Trick: Reading Buyers' Minds.

One of the reasons neurosciences is catching on is because it goes beyond just gut instincts and best practices to reach the reptilian brain—that area of the brain that controls the body's vital functions such as heart rate, breathing, body temperature, and balance. Neuroscience also factors in real scientific data. So much like agencies use data to back up media-buying decisions, for instance, neuroscience properties can support creative decisions.

10.3 ADS IN VIDEO GAMES

Advertising in video games is the integration of advertising into video games to promote products, organizations, or viewpoints.

There are two major categories of advertising in video games: in-game advertising and advergames. In-game advertising shows the player advertisements while playing the game, whereas advergames are a type of game created to serve as an advertisement for a brand or product.

Other methods of advertising in video games include in-game product placement and sponsorship of commercial games or other game-related content

In-game advertising is similar to product placement in films and television, where the advertising content exists within the universe of the characters. These forms of product placement are common, which led to the advertisement technique being applied to video games to match evolving media consumption habits. According to the Entertainment Software Association in 2010, 42% of gamers said they play online games one or more hours per week. Game playing is considered active media consumption, which provides a unique opportunity for advertisers. The principal advantages of product placement in gaming are visibility and notoriety. A single in-game advertisement may be encountered by the player multiple times, and advertisers have an opportunity to ally a brand's image with that of a well-received game.

Billboards, storefronts, posters, apparel, vehicles, weapons, fliers, sponsored product placement, and the interplay between the player and these elements in the game allow for a great degree of virtual advertisement. Examples of marketing in video games include brand integration, embedded marketing, recruitment tools, edutainment, and traditional in-game advertising.

According to Forbes, in-game advertising is expected to reach $7.2 billion in 2016. Unlike television commercials and digital ads, which can be avoided by using DVRs and ad-blocking software, advertisements embedded within video games cannot be bypassed. A more recent example of in-game advertising is Google's placement of video ads between levels of games. These ads are usually branded inline, and TechCrunch reports that they have the potential to gain fast traction in Google's Ad Mob Service

10.4 DESIGNING VIDEO AND COMPUTER GAMES

Video game design is the process of designing the content and rules of video games in the pre-production stage and designing the gameplay, environment, storyline and characters in the production stage. The designer of a game is very much like the director of a film in many ways; the designer is the visionary of the game and controls the artistic and technical elements of the game in fulfillment of their vision. Video game design requires artistic and technical competence as well as sometimes including writing skills. As the industry has aged and embraced alternative production methodologies such as agile, the role of a principal game designer has begun to separate - some studios emphasizing the auteur model while others emphasizing a more team-oriented model. Within the video game industry, video game design is usually just referred to as "game design", which is a more general term elsewhere.

Video game programmers have also sometimes comprised the entire design team. This is the case of such noted designers as Sid Meier, John Romero, Chris Sawyer and Will Wright. A notable exception to this policy was Coleco, which from its very start separated the function of design and programming.

As video games became more complex, computers and consoles became more powerful, the job of the game designer became separate from the lead programmer. Soon game complexity demanded team members focused on game design. Many early veterans chose the game design path eschewing programming and delegating those tasks to others.

With very complex games, such as MMORPGs or a big budget action or sports title, designers may number in the dozens. In these cases, there are generally one or two principal designers and many junior designers who specify subsets or subsystems of the game. In larger companies like Electronic Arts, each aspect of the game (control, level design) may have a separate producer, lead designer and several general designers. They may also come up with a plot for the game.

Video game design starts with an idea, often a modification on an existing concept. The game idea will fall within one or several genres. Designers often experiment with mixing genres. The game designer usually produces an initial game proposal document containing the concept, gameplay, feature list, setting and story, target audience, requirements and schedule, staff and budget estimates.

Many decisions are made during the course of a game's development about the game's design; it is the responsibility of the designer to decide which elements will be implemented. For example, consistency with the game's vision, budget or hardware limitations. Design changes have a significant positive or negative impact on required resources.

The designer may use scripting languages to implement and preview design ideas without necessarily modifying the game's codebase.

A game designer often plays video games and demos to follow the game market development.

It is common for the game designer's name to misleadingly be given an undue amount of association to the game, neglecting the rest of the development team.

10.5 TESTING PRODUCTS

Product testing, also called consumer testing or comparative testing, is a process of measuring the properties or performance of products.

The theory is that since the advent of mass production, manufacturers produce branded products which they assert and advertise to be identical within some technical standard.

Product testing seeks to ensure that consumers can understand what products will do for them and which products are the best value. Product testing is a strategy to increase consumer protection by checking the claims made during marketing strategies such as advertising, which by their nature are in the interest of the entity distributing the service and not necessarily in the interest of the consumer. The advent of product testing was the beginning of the modern consumer movement.

Product testing might be accomplished by a manufacturer, an independent laboratory, a government agency, etc. Often an existing formal test method is used as a basis for testing. Other times engineers develop methods of test which are suited to the specific purpose. Comparative testing subjects several replicate samples of similar products to identical test conditions.

10.6 AUGMENTING COGNITION

Augmented cognition is an interdisciplinary area of psychology and engineering, attracting researchers from the more traditional fields of human-computer interaction, psychology, ergonomics and neuroscience.[1][2] Augmented cognition research generally focuses on tasks and environments where human–computer interaction and interfaces already exist. Developers, leveraging the tools and findings of neuroscience, aim to develop applications which capture the human user's cognitive state in order to drive real-time computer systems. In doing so, these systems are able to provide operational data specifically targeted for the user in a given context. Three major areas of research in the field are: Cognitive State Assessment (CSA), Mitigation Strategies (MS), and Robust Controllers (RC). A subfield of the science, Augmented Social Cognition, endeavours to enhance the "ability of a group of people to remember, think, and reason."

10.7 SELF CONTROL

Self-control is the ability to regulate and alter your responses in order to avoid undesirable behaviours, increase desirable ones, and achieve long-term goals. Research has shown that possessing self-control can be important for health and well-being.

Common goals such as exercising regularly, eating healthy, not procrastinating, giving up bad habits, and saving money are just a few worthwhile ambitions that people believe require self-control.

10.8 SELF-CONTROL IN THE PUBLIC EYE

Self-control is being able to appropriately manage your thoughts, feelings, and impulses. People with self-control pay attention to their emotions and feelings. On the internet, self-control translates to "self-reflect before your self-reveal."

Developing self-control is more challenging for some kids than others. Learning self-control is a process and doesn't entirely gel until certain brain functions are formed in young adulthood.

Teachers, parents, and even other peers have a big influence on kids' self-control -- both in the "real" world and online. Help your kids develop self-control by helping them stay focused, avoid distractions, and think through the consequences of their actions.

10.9 LOOKING INTO THE FUTURE

It is clear that the next 50 years will be marked not only by a more comprehensive understanding of the system that allows us to interact with the world around us, but also by fundamental changes in how neuroscience research is accomplished and the very topics that are studied. Among these changes, neuroscientists must acknowledge the importance of diversity. To date, research in male (across species) and right-handed subjects has predominated. Additionally, clinical trials and genetic studies continue to overwhelmingly assess individuals of European descent. These systemic barriers to a comprehensive understanding of neuroscience, and the individual differences contained therein, are driven, in part, by a lack of diversity within neuroscientists themselves. As a result, the field suffers from a lack of understanding with respect to sex differences and the female brain, and FDA- or EMA-approved drugs frequently exhibit decreased therapeutic efficacy in nonwhite populations. Looking forward, we must prioritize greater diversity in both our researchers and our research subjects.

Neuroscience in society

The impacts of neuroscience research extend far beyond the clinic to the classroom, the courtroom, and even the grocery store. Indeed, neuro-technologies are already moving into our homes, promising to boost cognitive abilities, despite insufficient rigorous evidence of efficacy.

Neuroeducation, a field that combines research findings in developmental and cognitive neuroscience with educational strategies, has contributed greatly to our understanding of how students with dyslexia, attention deficit hyperactivity disorder, and other disorders learn. This knowledge has been used to implement changes in math, arts, and science curricula for students with these disorders. Recent evidence also shows that intertwining arts and science education allows students to find more creative and innovative approaches to solving problems. Despite this progress, cognitive psychology and neuroscience are not broadly implemented in standard educational practices of teachers in both primary and higher education. Further application of neuroscience and development of research in this space are beginning to change when mathematics concepts are taught and fundamentally change the way we schedule school days to align with circadian rhythms. Over the course of the next 50 years, we expect to see broader application of neuro educational strategies across age and educational setting.

Neuroscience is becoming increasingly more common in the courtroom as it is used to explain criminal behavior. Its use will increase over the next 50 years as researchers become more knowledgeable about the neurobiological mechanisms underlying decision making. Moreover, as diagnostic tools, human neuroimaging methods in particular, become more advanced and afford researchers greater insight into brain function, these strategies will be used to determine an individual's culpability and even likelihood for recidivism.

Although it may not be apparent in our everyday lives, companies all over the world are using the results of neuroscience research to inform their business practices from office structure to product placement and marketing strategies. This will likely increase over the course of the next five decades as our understanding of the neurobiology of cognition and attention matures. In particular, wearable neurotechnology has the potential to play a prominent role in providing instant consumer feedback allowing personalized marketing strategies that update in real-time. However, companies should exercise caution and follow ethical principles when developing new strategies to generate profit based on neurobiological understanding and techniques.

Beyond examining the complexity of the nervous system, itself, we must ask ourselves how we study this system of systems. When considering the approach that other scientific fields with seemingly infinite complexity have taken, the study of space comes to mind. While individual nations have embarked on space exploration over the last century, collaboration across disciplines and countries likely contributed to the great strides made thus far. Borrowing from this example, interdisciplinary approaches, with teams of mathematicians, engineers, computer scientists, biologists, and chemists, are key to the continued advancement of neuroscience. Presently, neuroscience is funded in many countries through numerous agencies; however, recent national and international initiatives facilitating large-scale interdisciplinary neuroscience are emerging. The BRAIN Initiative and the Human Brain Project, for example, have not focused on one specific area of neuroscience but instead embraced participation from researchers spanning science, engineering, math, and technology.

The vitality of SfN, whose annual meeting has grown from 1395 to >30,000 attendees per year, highlights its immense value as a central space for scientific dialog and collaboration. Expansion of these centrally coordinated efforts to accelerate brain research as well as a strong community of scientists will be instrumental in elevating the quality and capability of neuroscience research as it continues to explore the unknown.