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Review Article

Pupillometry Reaction and its Emotional Relationship During Bi-Sensorial Stimuli in University Students

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Abstract

This research, based on a study of neuro-physiological responses generated by emotional reactions, helps advertising agencies understand how they can use consumer neuroscience to develop more effective advertising campaigns. The study makes use of biometric tools which identify how specific stimuli can influence the consumer decision making process. Our aim is to enable agencies to use these tools on a daily basis to create more persuasive campaigns. With the globalization of brands and the need to remain competitive by understanding changing consumer preferences, it is increasingly important to have the right tools and to be able to execute new ways of positioning in the market [1].

Keywords: *Pupillometry; Emotions; Stimuli; Multi-Sensorial; Neuromarketing; Consumption; Advertising Agencies*

Description

This research has involved 52 university students and establishes the relationship between contingent alteration pupillometry with the multimodal (Video and Audio) and basic emotions – fear and happiness - stimuli which were exposed to the participants of this study. The identification of the type of the emotional response can determine if people will have a positive or negative response for a product or a brand affecting in a direct way the consumer making decision process for buying or consuming a specific product. Once the stimuli have been received by the nervous system it provokes neurophysiological and neuropsychological reactions that had been activated by the reward control system or the inhibitory control system that are located in the specific regions of the brain such as: nucleo accumbens and tegmental ventral area. These reactions are able to affect consumer´s behavior related to the procurement decision process to acquire goods and services.

Measurement of the pupillary diameters after applying different stimuli can provide an explanation to the type of emotions that generates and identifies both the valence and the intensity of this perception that can be correlated with the consumer decision and buying process, as well as his attitude toward life. The research has been done on a population of university students, 52 selected subjects, 13 men and 13 women with blue/green eyes and 13 men and 13 women with browns eyes. Filters regarding some characteristics of the sample were taking into account such as: health status, age (18 to 24), education level, eyes color, among others. The visual stimuli were taken from standardized and validated worldwide test such as TAT, CAT and Baron Cohen test. In addition, the auditory stimuli were taken from soundtracks of classic films on comedy or horror. The research methodology was mixed, with correlational and descriptive approach.

The preliminary information of the study suggests that there are some correlations between the type of the stimuli and the pupil dimeter reaction. In addition, that the color of the eyes of the subjects is also a factor that should be taken into account at the moment of the evaluation of any kind of advertising. A deeper analysis of the database it's been analyzed and will provide new evidence about the time response of the pupil after the stimuli had been shown.

This work presents an opportunity for advertising agencies may have relevant information about consumer behavior when they are establishing communication strategies and the execution involves the usage of photographs or audios in their advertising material such as billboards, videos, tv commercials, posters, flyers among others.

Introduction

The application of neuroscientific techniques in the field of marketing have given rise to what is known as neuromarketing, a technique that facilitates the identification of brain centers activated by the presence of stimulus received through the sense organs, and whose neurocognitive response is feasible. To measure given the reward mechanisms that activate the brain regions related to making-decision and their respective valence, which in addition to relating and identifying them, helps to predict the behavior of the consumer when being persuaded to make decisions [2]. That is, neuroscience facilitates the identification and relationship that exists between the stimuli perceived through the sense organs, the activation of inhibitory mechanisms and the making-decision process related to the acquisition of goods or services [3].

Neuromarketing, as emergent knowledge, derives its knowledge from clinical neuroscience, from which emanate stimulation - neurophysiological response and stimulus - neurocognitive response studies, which have been the object of research for various neuropathologies; now used by the neurosciences applied to organizations, marketing and health, which have grown so far in the XXI century, both at the academic, labor and research levels. The processes studied and the methods used by neuromarketing today come from neurology and psychology under a conceptual economic framework, which take brain function as a starting point (Lezak, Howieson and Loring, 2004); from which derives the relevance of documenting this field of application from the theoretical contributions, and specifically the importance of neuroconsumption both in the business field and in consumer behavior.

To identify these levels of activation or neuroscientific research that facilitate correlating the functions that lead the brain areas that are activated, we resort to invasive and non-invasive techniques, with technologies such as pupillary diameter meter - ET, facial expressions analyzer - FCA, electroencephalography - EEG, computerized axial tomography - TAG, magnetic resonance imaging - MRI, positron emission tomography - PET, functional magnetic resonance imaging - fMRI [4]); which allows to identify them from the neurosensory responses.

The human being is an animal of high complexity

The human being is an animal of high complexity, because it combines in an articulated way different elements:

- Existential being: creates a sense of transcendence that impels you to leave a mark on your environment, which can be reflected in your heritage to your children, society, friends or family, while generating ideas of immortality, true or not according to each person, who promote the creation and implementation of values.
- Social being: for its gregarious reason and specific cultural events, a grouping is generated that develops an intricate network of inter and intrapersonal relationships to produce a complex society, which, although it presents patterns of social conditioning, does not leave free elections aside. adaptive
- Psychological being: There is an emotional interaction where both drives and repressions, conditioning as self-realization, fears and pleasures that, combined, mark temperamental aspects (character and personality).
- Biological being: The neuroanatomical and neurophysiological substrate enables the development of social, psychological and cultural elements, and in some way, also determines them.

It is worth mentioning that the Human Being is a combination of the previous aspects, where none predominates, they are intertwined with a synergy that has achieved an adaptation as a species, which, to date, places it at the head of the evolutionary chain.

Neuroscience studies the structure and chemical function, pharmacology, and pathology of the nervous system and how different elements of the nervous system interact and give rise to behavior. (htt: //neurocienciaeia.blogspot.com). Cognitive Neuroscience studies the combination of neuroscience and psychology, proposes a way of studying the brain and voluntary and involuntary actions supported by neurobiology, neurology, psychobiology and psychology.

Cognition

The most accepted definition of cognition is the ability of living beings to process information from perception (stimuli that come from the outside world through the senses), knowledge acquired through experience and our subjective characteristics that allow us to integrate all this information to value and interpret the world. The word cognition comes from the Latin "cognoscere", which means to know. Therefore, when we talk about the cognitive we are usually referring to everything that belongs or is related to knowledge, that is, the accumulation of information that we have acquired thanks to learning or experience. Cognition is the ability we have to assimilate and process the data that comes to us from different ways (perception, experience, beliefs) to turn them into knowledge. Cognition encompasses different cognitive processes such as learning, attention, memory, language, reasoning, decision making, etc. that are part of intellectual development and experience. Different disciplines have addressed the study of cognition, neurology, psychology, anthropology, philosophy and even the information sciences. But it was cognitive psychology that began to study how information processing influenced behavior and how different mental processes related to the acquisition of knowledge. Cognitive psychology emerged at the end of the 50s as a contrast to the prevailing behaviorism of the time. Authors such as Piaget and Vigotsky revolutionized the scientific landscape thanks to their theories about development and cognitive learning, which are still valid today. From the decade of the 60s, interest in cognition and cognitive abilities increased exponentially, and the number of investigations that were generated allowed to increase the knowledge we have about these processes. Currently, advances in neuroimaging allow us to add a physiological and neuroanatomical knowledge very important for the understanding of mental processes and how these influence our behaviors and emotions.

Cognitive processes

Cognitive processes can be understood as the procedures we use to incorporate new knowledge and make decisions about it. In these processes several cognitive functions intervene: perception, attention, memory, reasoning. All these cognitive functions work together to integrate knowledge and create an interpretation of the world around us.

Perception

Allows us to organize and understand the world through the stimuli we receive with the senses. We can receive information from the five classical senses such as sight, hearing, taste, smell and touch, but also from others not as well known as proprioception (sense that informs about body position, allows to identify the body schema and know the position that is occupied in the space) or the interception (perception of how the organs of the body are, allows to know when one is thirsty or hungry). Once received, our brain integrates all this information, creating a new knowledge.

Attention

Cognitive process that allows you to concentrate on a stimulus or activity, and then be able to process it more deeply in consciousness. Attention is a fundamental cognitive function for the development of daily life and is used in most tasks.

Memory

Cognitive function that allows coding, storing and retrieving information from the past. Memory is a basic process for learning and allows creating a sense of identity. There are many types and classifications of memory, you can talk about short-term memory, which is the ability to temporarily keep the information in mind (remember a phone number in mind until we get to write it down on paper), and from memory to long term that are all those memories or knowledge that are saved for much longer. This in turn can be divided into declarative memory, which includes both knowledge acquired through language and education (for example, knowing that the civil war ended in 1939) and those acquired through personal experiences and experiences (remember what cooked me my grandmother in the village); or procedural memory, which refers to the learning of routines (for example, learning to drive or go cycling), auditory memory, contextual memory, denomination, recognition.

Thought

Fundamental in every cognitive process. It allows to integrate all the information received and establish relationships between the data that compose it. To do this, it uses reasoning, synthesis and problem solving, that is, executive functions.

Language

Ability we have to express thoughts and feelings through the word. It is the tool used to communicate, organize and transmit information about us and about the world. Language and thought develop in parallel and are intimately related, influencing each other.

Learning

Cognitive process through which we incorporate new information to our prior knowledge. In the learning includes the learning of behaviors or habits, the knowledge that acquired with the socialization and the school. Piaget and other authors spoke of cognitive learning as the process in which information enters the cognitive system and changes it.

Neurotransmitters and synapses

A neurotransmitter (neuromediator or second messenger) is a biomolecule that allows neurotransmission, that is, the transmission of information from a neuron (a cell type of the nervous system) to another neuron, a muscle cell or a gland, through the synapse that separates them. The neurotransmitter is released from the synaptic vesicles at the end of the presynaptic neuron, towards the synapse, through the synaptic space and acts on the specific cell receptors of the target cell. Neurotransmitters can be grouped into neurotransmitters themselves, and neuromodulators. The latter are substances that act in a similar way to neurotransmitters; the difference is that they are not limited to the synaptic space, but rather they are diffused by the extra neuronal fluid, intervening directly in the postsynaptic phase of neurotransmission. Taking into account their chemical composition can be classified into:

- Cholinergic: acetylcholine
- Adrenergics: which are divided into catecholamines, for example adrenaline or epinephrine, norepinephrine or norepinephrine and dopamine; serotonin, melatonin and histamine
- Aminoacidérgicos: GABA, taurine, ergothioneine, glycine, beta alanine, glutamate and aspartate
- Peptideptics: endorphin, enkephalin, vasopressin, oxytocin, orexin, neuropeptide Y, substance P, dynorphin A, somatostatin, cholecystokinin, neurotensin, luteinizing hormone, gastrin and enteroglucagon.

- Free radicals: nitric oxide (NO), carbon monoxide (CO), adenosine triphosphate (ATP) and arachidonic acid.

How neurotransmitters work: the neuron that releases the neurotransmitter is called the presynaptic neuron. The neuron that receives the signal is called the postsynaptic neuron. Depending on the type of receptor, postsynaptic neurons are stimulated (excited) or discouraged (inhibited). Each neuron communicates with many others at the same time. Since a neuron may or may not send a stimulus, its behavior is always based on the balance of influences that excite or inhibit it at any given time. Neurons are capable of sending stimuli several times per second. When a nerve impulse arrives at the end of the axons, a neurotransmitter discharge occurs in the synaptic cleft, which is picked up by specific receptors located in the membrane of the postsynaptic cell, which causes depolarization in this, consequently, A new nervous impulse.

Main neurotransmitters

- Acetylcholine (AC), are located in motor neurons in the spinal cord → neuromuscular junction, basal proscencephalon → numerous areas of the cortex, interneurons in the striatum. Autonomic nervous system → preganglionic neurons of the sympathetic and parasympathetic SNA, and postganglionic parasympathetic neurons.

- Dopamine, are located in: substantia nigra → central pathway of the striatum, limbic system and numerous areas of the cortex). Arcuate nucleus of the hypothalamus → anterior pituitary through the portal veins.

- Noradrenaline (NE), are located in: Locus Coeruleus of the extrusion → limbic system, hypothalamus, cortex. Spinal bulb → locus coeruleus, spinal cord. Postganglionic neurons of the sympathetic nervous system

- Serotonin, are located in: Nuclei of the protuberant raft → multiple projections. Spinal bulb/Protuberance → dorsal or posterior horn of the spinal cord.

- γ-Aminobutyric acid (GABA), are located in: Main inhibitory neurotransmitter of the brain; very extended cortical interneurons and long projection pathways.

- Glycine, are located in: Main inhibitory neurotransmitter of the spinal cord

- Glutamate, are located in: Main excitatory neurotransmitter; located throughout the CNS, even in cortical pyramidal cells.

Learning and biology: learning is understood as the process by which a human being acquires or modifies their abilities, skills, knowledge or behaviors, as a result of direct experience, study, observation, reasoning or instruction. In other words, learning is the process of forming experience and adapting it for future occasions: learning. It is not easy to talk about learning, since there are different theories and approaches to the fact. What is clear is that human beings and higher animals are endowed with a certain capacity for adapting behavior and solving problems that may result from environmental pressures or fortuitous events, but also from a voluntary process (or not) of teaching. Human learning is linked to personal development and occurs in the best way when the subject is motivated, that is, when he wants to learn and strives to do so. For this, he uses his memory, his capacity for attention, his logical or abstract reasoning and various mental tools that psychology studies separately. (Source: https://concepto.de/aprendizaje-2/#ixzz5q0doGvvo).

Neural Networks: A system of interconnection of neurons in a network that collaborates to produce an exit stimulus. Explained in a simplistic way let's say it is a set of nodes that processes and sends information to each other.

Origin and development of the concept of Neural Network: the first investigations on the subject date roughly from the beginning of the 19th century, but it was not until the decade of the 40s and 50s, in the 20th century, when it gained strength, thanks to the Connectionist

movement. This movement maintained the premise that the secret of the process of learning and knowledge is fundamentally in axioms or unquestionable truths and that knowledge is independent of the structure that symbols handle, and the representation of knowledge is made from the most basic stratum of intelligence: the brain, especially in neurons and the multiple connections between them. This remarkable interest in neural networks was diminished in the 70s due to the emergence of authors such as Minsky and Papert [5-14] who expressed the limitations of the learning process of neural network architectures. The central principle of connectionism is that mental phenomena can be described by networks of simple and often equal units that interconnect. The neuron is the fundamental unit of the nervous system and in particular of the brain. Each neuron is a simple processing unit that receives and combines signals from and to other neurons. If the combination of inputs is strong enough the output of the neuron is activated.

The brain consists of one or several billions of densely interconnected neurons. The axon (output) of the neuron branches out and is connected to the dendrites (inputs) of other neurons through junctions called synapses. The effectiveness of the synapse is modifiable during the learning process of the network.

Decision making: a decision is a resolution or determination that is made about something. It is known as making decision process that consists of making a choice between different alternatives. Making-decision can appear in any context of daily life, whether at a professional, sentimental, family level, etc. The process, in essence, allows to solve the different challenges that a person or an organization must face. When making a decision, various factors come into play. In an ideal case, one appeals to the analytical capacity (also called reasoning) to choose the best possible way; When the results are positive, an evolution takes place, a step to another stage, the doors open to the solution of real and potential conflicts. Any making decisionshould include a broad knowledge of the problem that is to be overcome, since only after the relevant analysis is it possible to understand it and find an adequate solution. Needless to say, in the face of trivial questions (for example, deciding whether to drink water or orange juice in a meal), the level of reasoning is much less complex and profound, and acts almost automatically, given that the consequences of a wrong decision They do not matter much. On the other hand, before truly transcendental decisions for life, we proceed in a very meticulous way, weighing the potential results, and the necessary time is much greater. Throughout the development of a person, regardless of their personality and their tastes, each new day brings with it an increasing number of problems to solve, and little by little we are turning into authentic machines specialized in making decisions. At first glance, we can distinguish between individuals who are safe and insecure of themselves. The first are usually determined, always have clear tastes and needs, which facilitates decision making; the others, on the other hand, lack the self-confidence necessary to consider their own ideas valid, and this has a serious impact on the critical moments of life.

In the making-decision process, the choice of a path to be followed is important, so in a previous state, alternatives for action must be evaluated. If the latter are not present, there will be no decision. To make a decision, whatever its nature, it is necessary to know, understand and analyze a problem, in order to give a solution. In some cases, because they are so simple and daily, this process is carried out implicitly and is solved very quickly, but there are other cases in which the consequences of a bad or good choice can have an impact on life and if it is in a labor context in the success or failure of the organization, for which it is necessary to carry out a more structured process that can give more security and information to solve the problem. Examine the possible consequences of each one of the proposed alternatives.

Conclusion

Thought is the result of neurochemical action, that is, mental processes are given by neurophysiological processes. Consciously directed thoughts can inhibit or promote the production of neurotransmitters that in turn affect both moods and physical health. Psychoimmunomodulation is understood as the result of brain chemistry secondary to thoughts.

Like all subjects related to the brain, emotions and their relationship with health - disease, there is still much to investigate and know, however, the future of neuroscience offers an encouraging vision for the human species.

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