

# Neuromarketing: A Systematic Review of Scholarly Articles

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## ABSTRACT

An extensive review of scientific literature on neuromarketing was conducted for this report. includes a full review of current-day issues of neuromarketing.

**Keywords**— Neuromarketing, Scholarly Articles, Marketing, Management

## I. INTRODUCTION

In the decade of 1950s, Vance Packard(1957) was the first person who exclaimed at how advertising agencies were utilizing knowledge of behavioural science and cognitive psychology to push their product based messages. Through this process, subliminal advertising campaigns would get success. The reason for this was to make advertisements which would have few words and little arguments (Ellul, 1964, p. 364). The main objective of the ad agencies was to present a certain way of life. In other words, it can be said that the objective was to implant in the mind of consumers a certain desirable way of leading life(Girard, 1976). Over the years the diagnostic aspects of neuro science have been combined to give birth to a new field, a combination of consumer psychology and marketing i.e. neuro marketing. Through neuromarketing, the response of consumer reaction towards advertising stimuli is assessed by utilizing the brain and bioimaging technologies. Over the years neuromarketing has proved to be a very effective tool in assessing an ad's effectiveness.

According to experts, neuromarketing is a combination of biology, psychology and neuroscience (Stanton et al., 2017; Plassmann, Venkatraman, Huettel, & Yoon, 2015).Through neuromarketing, neurophysical tools are utilized to study consumer buying behaviour(Javor, Koller, Lee, Chamberlain, & Ransmayr, 2013). Neuromarketing is also used to mobilize customer demand for the marketer's product (Farah, 2014). Neuromarketing has emerged as a very strong tool in the hands of advertisers. Combining behavioural psychology, brand mapping and imaging, its helping marketers through different means. Offcourse, as per critics, neuromarketing intends to manipulate consumer buying behaviour by decoding the affect and instinctive behaviour of consumers. Though neuromarketing is an extension of traditional marketing, but the forms of consumer persuasion are different.

When traditional marketing emphasizes on desire and emotion, neuromarketing bypasses the reflective sensing abilities of consumers. As per experts, neuromarketing tends to learn the process through which people think about buying a product.

Though neuromarketing is implemented in a lot of areas but still in the world of academic research more studies need to be done on it. According to Morin,(2011) the reason for the lesser amount of studies, is that most marketing researchers lack formal training in neuroscience. Also there are concerns regarding privacy and ethical issues of neuro marketing. Scholars are also pointing towards the fact that despite high hopes regarding neuromarketing are sold by the related companies, still considering the current level of technology it's not fully possible to penetrate fully into subconscious mind(Wolpe 2004,Alpert 2007,Illes 2007, Crockett 2012).

However, neuromarketing these days have gained in popularity. A simple search in Google will indicate that from a few hits in 2002, the number of hits touched thousands in 2010(Morin,2011). At the present moment, clients are increasingly asking ad agencies to become more like partners, to take more active role in decision making. Also it has become crucial in studying consumer behaviour through brain imaging tools. Thus, studying about neuromarketing has become very important.

Through detailed review of scholarly articles, this study will delve into various aspects of neuromarketing starting from its application in corporates upto ethical aspects. Through compilation of results of different studies this study will try to give directions for future studies.

## II. THEORETICAL FRAMEWORK

A theoretical framework is always necessary before getting into further details of literature reviews. Previous studies need to be introspected, which had analysed the different parts of human brain as they played a significant role in emotional and cognitive functions. (Solnais et al., 2013).

**Decision Taking:** A very significant function of the human brain is decision taking. Throughout lifespan of a person the brain takes and aids in different types of decision makings. This is one of the reasons due to which the brain constituting 2% of human body consumes 20% of its energy. It's a common attribute of

consumers that they evaluate cost-benefit analysis of products during purchase. The prefrontal cortex (PFC) of the human brain takes an active part in decision making. Both the ventrolateral prefrontal cortex (VMPFC) and orbitofrontal cortex (OFC) engages in analysis of values, outcomes and alternatives related to purchase (Daw, O'Doherty, Dayan, Seymour, & Dolan, 2006; Tremblay & Schultz, 1999). According to Wallis (2007), the OFC evaluates capacity of a product to satisfy needs and related trade-offs. During unpredictable situations, it also takes an active part in making the right choices (Elliott, Dolan, & Frith, 2000). On the other hand, the dorsolateral ventrolateral prefrontal cortex (DLPFC) plays a role in big decision makings by putting cognition over emotion (Rilling, King-Casas, & Sanfey, 2008). It also compels human beings to go by social norms so as not to confront with others (Rilling & Sanfey, 2011). PFC's cognitive ability gets down when a sure gain is expected (Gonzalez, Dana, Koshino, & Just, 2005). Thus measuring the different regions of the brain will help in their impact on neuro marketing.

**Rewards Recognition:** Another region has also evinced interest among researchers. That part deals with processing and recognition of rewards. The rewards can be drugs (Wise & Rompré, 1989), money (Knutson, Adams, Fong, & Hommer, 2001) and food (Berridge, 1996). Striatum, located at frontal part of brain plays in reward processing and recognition of the brain as per one's expectation (Knutson & Wimmer, 2007), considering social factors (Fliessbach et al., 2007). Also, Ventral tegmental area (VTA) plays an active role in reward processing and recognition. It also plays in the transportation of dopamine also known as neurotransmitter to other parts of the brain. VTA plays in decision making and goal seeking behaviour of human beings (Fields, Hjelmstad, Margolis, & Nicola, 2007).

**Withdrawal and Approach Motivation:** As per neuroscience, human motivation is dependent on two factors: anticipated positive outcome or possible negative outcome which needs to be avoided. EEG studies have proved that left frontal cortex leads to approach behaviour (Davidson, 2004). Again the right frontal cortex leads to withdrawal behaviour (Davidson, 2004). In other words left frontal cortex is responsible for positive emotions (Harmon-Jones, 2003) and right frontal cortex is responsible for negative emotions (Harmon-Jones, 2003). The left-right asymmetry of the brain is the main area of research for neuromarketing experts as they play a pivotal role in consumer attraction towards a brand or product.

**Emotional Processing:** Amygdala, also known as the locus of fear and aversive memory (Maren & Quirk, 2004) is another part of the brain which plays in processing of unknown stimuli and negative emotion (Rilling & Sanfey, 2011). To a little extent it also processes positive emotion in connection with rewarding stimuli (Murray, 2007). Another vital region of the brain, the insular cortex carries out processing of risk expectation or perception during the time of decision

making which involves financial or social risks (Knutson & Bossaerts, 2007; Preusschoff, Quartz, & Bossaerts, 2008). Also an active insula leads to disgust and anger in uncomfortable situations (Sanfey et al., 2003). When a negative difference takes place between expectation and output, the emotion of regret takes place through OFC (Coricelli et al., 2005). Bush, Luu, & Posner (2000) proved that anterior cingulate integrates motivational and emotional information with decision making after thorough evaluation. It also deals with conflict between emotional and cognitive emotions (Sanfey et al., 2003). Through the somatic marker theory (Reimann & Bechara, 2010), the process of emotional decision making can be further explained. As emotion plays a very important role in purchase decision of customers so brain mechanism studies are very essential in this regard (Bagozzi, Gopinath, & Nyer, 1999). As no single brain region is involved in overall emotional processes so, the brain mechanisms need to be studied from an overall point of view in order to implement neuromarketing (Phan, Wager, Taylor, & Liberzon, 2002).

**Memory and Attention:** With regard to memory, the hippocampus nestled in temporal lobe carried out memory processing which is necessary in advertisements recall and brand awareness (McGaugh, 2000). Next to the hippocampus is the amygdala which acts as a modulator and consolidator of memory system (McGaugh, 2000).

As product design, logos, advertisements, captions, visual merchandising have aesthetic elements so here also brain mechanisms are required in processing of visual stimuli. The prefrontal cortex and occipital lobe regions of brain are responsible for visual stimuli processing (Armstrong, Fitzgerald, & Moore, 2006). Thus the previous studies build up a strong foundation for further introspection of different scholarly articles related to neuro marketing.

### III. METHODOLOGY

For literature review Tranfield approach (Tranfield et al. 2003) approach was adopted. The review took place in stages.

In stage 1, by utilizing different databases articles were searched.

In stage 2, the articles were monitored emphasizing on the different aspects of neuromarketing. For this, the keywords, abstract, title were given emphasis. The keywords include neuro marketing, neuroscience, consumer psychology, brain mapping etc.

In stage 3, articles were finalized for conducting the study. In total, 102 articles were utilized for this paper.

The following research question (RQ) was proposed as per the study of Manimuthu et al., (2019).

**What is Neuromarketing? How has it been reflected in different scholarly articles?**

#### IV. WHAT IS NEUROMARKETING?

According to Stanton et al.(2017), Neuromarketing is that discipline through which neurological tools are applied to gain insights into decision making, taste and preferences, cognition of consumers. It seeks to gain knowledge beyond traditional means of marketing research with the objectives of gaining new insights in marketing (Yoon et al. 2012, Plassmann et al. 2015), right prediction of consumer behaviour(Venkatraman et al. 2015; Boksem and Smidts 2015; Smidts et al. 2014).As per Plassmann et al. 2012, the distinction made between neuro science and neuro marketing is that neuro marketing is the branch of neuro science which is applied for industrial purposes.

For the purpose of studies on neuro-marketing several techniques are used by researchers. The first technique used is Functional magnetic resonance imaging(fMRI). fMRI measures deoxygenated haemoglobin(Huettel et al. 2014). Deoxygenated haemoglobin measures the neuronal activities related to spatial resolution (upto one millimeter) and temporal resolution(changes in terms of seconds). Infact neural responses with regard to deoxygenated haemoglobin lead to consumer response towards music which further impacts sales (Berns and Moore, 2012).

Another technique used by neuro marketers is electroencephalography (EEG). EEG measures electrical activities of the brain by placing electrodes in scalp. In order to show the example of utilization of EEG for industrial use, Boksem and Smidts (2015) pointed out responses of brain to movie trailers as estimated through EEG. It can also help in giving an idea regarding single additional response. Another technique named Magnetoencephalography (MEG) measures fluctuating magnetic fields instead of oscillating electrical activities. Instead of brain imaging, as an alternative measure, researchers can also estimate peripheral physiological results such eye tracking, pupillometry, conductance, skin, respiration and heart rate, placebo effects (Venkatraman et al. 2014;Reimann et al. 2012;). Thus, researchers can relate consumer experience with physiological results.

Neuromarketing thus can measure not only brain imaging techniques but also the above results.

#### V. HISTORY OF NEUROMARKETING

As mentioned before, the combination of neuroscience and marketing constitutes neuromarketing. The term, neuromarketing cannot be attributed to a single company or person. It started in an organized manner since 2002. Companies like Sales Brain and Brighthouse started offering these services(Morin,2011). The main essence of neuromarketing is to look towards consumer behaviour through the human brain. As per

Morin(2011), McClure(2004) was the first person to do an academic research on neuromarketing. In his study he asked customers to test Coca Cola and Pepsi and measured their brain activities through an fMRI machine. He showed that depending on the brand consumption our brain definitely lights up. He showed that a strong brand name like “Coca Cola” activates our brain’s frontal cortex.

Ariely & Burns(2004) on the other hand pointed out towards the ethical aspects of neuromarketing. They questioned the morality of neuro marketers as neuromarketers openly said that there will be a “Buy” button in the hands of marketers. Just by clicking on that button they will be able to make customers to buy their products. In 2005,Harper Collins was the first publishing company to have coined the term “Neuro Marketing” (Morin,2011). After that, though there have been protests against neuro marketing none have been able to put a dent on its rising popularity among corporates. Infact, neuromarketing these days is a multibillion dollar industry.

#### VI. PRACTICAL EXAMPLES ON NEUROMARKETING

Before getting into more detailed analysis of literature related to neuromarketing it’s necessary to know its practical applications. As per compilation done by Farnsworth(2019), below are the practical applications of neuromarketing:

- a. **Eye Gaze:** Dooley(2009) found that for long, advertisers have been putting adorable faces of kids to attract the customers. Neuromarketing’s eye tracking technology has shown that simply putting the kid is not enough as customers will remain hooked towards the kid’s face. That’s why the kid must look at the product or the text so as to attract the attention of customers towards the product.
- b. **Effective Packaging:** Dube(2017) in her study emphasized on effective packaging. It’s a well known fact that packaging is important to sell a product. But, neuroimaging technologies have taken packaging to a new level. Companies like Frito-Lay and Campbell have found that customers in neuro imaging have expressed negative response to shining glitzy packaging. Infact they prefer more of the matte looks. That’s why Frito-Lay removed all shiny looking packages and replaced them with the matte ones.
- c. **Colour:** Colour puts a big impact on customers and their physiological reactions. That’s why several brands use vibrant colours. Examples are Coca Cola’s red, Pepsi’s blue. Several brands catering towards young customers use red as it increases heartbeats thus applicable in case of emotions like love. On the other hand

blue is a colour for professionalism. Uber used black and white to show its premium positioning.

- d. **Ad Efficiency:** For decades, only the academic and scientific researchers have spent valuable time on brain imaging. Now, with the advent of neuromarketing, fMRI technology (Functional magnetic resonance imaging) is helping marketers in a big manner to study consumer behaviour. Consumers are shown different types of advertising campaigns. Then their response towards the campaigns is evaluated by using fMRI. The one which will lead to greatest reaction from consumers are used for the final campaigning. Thus, a successful ad campaign can put significant impact on sales.
- e. **Decision Paralysis:** Tugend(2010) found that too many options make the customers confused. Infact, too many choices act as a deterrent for customers. By using different setups using visual merchandising techniques (VM) displays with different options fail to attract customers. Great example in this regard is of Colgate and Crest. Colgate presents fewer toothpaste options for the customers. Crest on the other hand presents huge number of options. There was a time when Crest used to keep 70 different types of tooth pastes on shelves. Infact, seeing decision paralysis of customers, Colgate combined all necessary nutrients in only one product i.e. Colgate Total. Other brands who have worked in this regard are Whole Foods, Etsy, Nudge. That's why Puri(2016) said that brands must provide lesser options and more guidance to customers. Customer education and not customer confusion should be the key.
- f. **Satisfaction Evaluation:** Emotional Response Analysis (ERA) is a very effective tool in the hands of marketers to study a customer's emotional response to a product advertisement. All is good if positive response is expressed. In case of negative response corrective actions need to be taken.
- g. **Loss Aversion:** Customers never want to lose out on good deals. They are always looking for deals. That's why brands always provide different deals to customers in the form of discounts, freebies and other promotions. That's why "framing" is a concept which is used in the world of neuro marketing. It says of a way through which advertisers can place their products to customers so that they will start splurging their money.
- h. **Anchoring Effect:** Miller(2016) found out that "Anchoring" puts a great impact on customers. According to neuroscientists, the first information received by customers is very crucial for the final decision making. It means customers rarely evaluate products based on

their intrinsic worth. They go by the surrounding features or facilities. In other words, many times augmented product gets more importance than core product.

- i. **Pace:** Lindquist(2019) pointed out that Paypal in its neuromarketing experiments on customers, found out that the brain of customers reacted more favourably to features like pace and convenience rather than security and safety. Seeing such test results, Paypal then designed its advertisements accordingly.
- j. **Hidden Responses:** Many times it has been found that the insights from market research on consumers fail. The reason is that consumers hesitate to reveal their real feelings. This hesitation stems from culture and past experiences. Offline retailers find that many times customers during filling up of feedback forms opine that all is good in the store while their inner feelings are different. Neuromarketing can help researchers in this regard. Snacks brand, Cheetohs, once found that direct customer feedback and insights on neuromarketing tests on them are totally opposite.
- k. **Rewards and Punishments:** Videogame companies are using this tool very efficiently. They always keep rewards at every stage of the game. Neuromarketing studies have shown that rewards increase the dopamine of the brain. Dopamine is also known as "Neurotransmitter". A neurotransmitter is associated with positive feelings which make the game more engaging.
- l. **Prototype:** Prototypes are also very effective for companies. Hyundai in its EEG study studied brain activities to know how consumer brain would react to different car designs. Based on the results it changed the exterior design of its cars.
- m. **Pricing:** Wadhwa & Zhang(2014) carried out their study on pricing and consumer behaviour. They said that rounded numbers based pricing encourage reliance on feelings. Whereas non rounded numbers emphasizes on cognition.
- n. **Layout:** Both online and offline retailers are carrying out different experimentations with regard to layout. design of the store, customer traffic, timing, colour, lighting, props in order to attract, entice and engage customers.

## VII. CONSUMER NEUROSCIENCE

A good number of researchers carried out their studies by accepting neuromarketing as "consumer neuroscience". Studies on consumer neuroscience will be crucial to understand neuromarketing.

In the first decade, efforts were made to understand how consumer neuroscience impacts

consumer decision making. In their study, Smidts et al.(2014) inspected the progress of consumer neuroscience and compared it with the related disciplines of neuro economics.. Three new upcoming frontiers were discussed considering applied and theoretical levels of neuroscience. First, the field will evolve to include molecular neurology and genetics to gain greater insights into consumer decision making. Second, recent progress made in computing power will lead to a lot of progress in neuroscience. Third, neuroscientists will synthesize the specificity and consistency of the consumer brain. Just like Smidts et al.(2014), another group of researchers, Plassmann et al.(2015) also studied the progress of research on neural processes affecting human decision and judgement. For more progress the marketing implementations of technological advancements must be also taken into consideration. For this, Plassmann et al.(2015) suggested five paths through which neuro science can be applied in marketing in the form of neuromarketing. The paths are mechanism identification, implicit process measurement, dissociation between psychological processes, understanding individual differences and lastly improving behavioural predictions. They also outlined three challenges faced by neuromarketers which are as per below:

- a. Consumer neuroscience tends to understand the consumer's brain and not his behaviour.
- b. In order to study psychological processes, primarily, consumer neuroscience relies on backward inference.
- c. Neuroimaging studies are more generalizable and reliable than older marketing studies.

With the boom in neuroscience and its effectiveness in studying brain mechanisms the ultimate result was consumer neuroscience through which researchers tried to study consumer behaviour. However few marketing scholars are still hesitant in using neuroscience as they are still not sure about effectiveness of neuroimaging data. In order to fill up the gaps in this regard through a semantic cluster analysis, Solnais et al.(2013) carried out review on 34 scholarly articles.. Then they framed an approach of classifying and analysing the data with regard to emotions, memory, rewards and decision-making. They also discussed contributions of several brain mechanisms and how the results could be integrated with traditional consumer behaviour theories.

Another factor which play very significantly in the world of consumer neuroscience is color. Colors play an important role in cognitive reactions of the brain. As proved by EEG signals different colors lead to different mental arousals and cognitive activities. As color plays an important role in packaging industry so, for neuromarketers it acts as a treasure-trove of great insights. That's why Rakshit & Lahiri(2016) studied about the impact of colour on cognitive state of consumers. Their study also dealt with different colors from EEG signals so as to study their impact. Based on four color stimuli; blue, yellow, green, red they studied

the different activation areas of the brain with regard to each color. Their study also employed an Interval-Type-II fuzzy space classifier in order to distinguish between the different stimuli. They found that the classification rate is minimum for yellow color and maximum in case of red. Applying the Friedman test(1940) they showed how the colors can be effective in packaging world.

Gurbuz & Toga(2018) on the other hand used the FACS (Facial Action Coding System) for consumer gender profiling. Their study had two objectives. First objective was to determine the best product family and most appropriate sector for neuromarketing application related to Multi Criteria Decision Making (MCDM). With the help of literature review the most suitable sectors for neuromarketing applications were decided by them as the sectors of retailing, information technology, automotive and finance. Again, through questionnaire survey, the most proper product family and sector were chosen by using Grey Relational Analysis (GRA) and Analytical Hierarchy Process (AHP). The second objective was to implement neuromarketing based on the GRA results. FACS was used to study gender profile of customers with relation to product family. The results proved the effectiveness of FACS in studying customer gender profiles. Finally through the Artificial Neural Network (ANN), relationships between FACS results and customer profile were analysed.

A very important point to be noted in this regard is that Functional Magnetic Resonance Imaging (fMRI) studies are proving to be crucial in all neuroscientific studies. That's why Dimoka(2012) in her study outlined the guidelines of conducting fMRI studies so as to generate great effectiveness. In her study she also discussed the different steps required to conduct fMRI tests properly thus contributing to existing literature.

In another study, Dimoka et al.(2012) discussed the contribution of neuroimaging tools (e.g., fMRI, EEG) and psychophysiological tools (e.g., EKG, eye tracking) in consumer neuroscientific studies. The article at first discussed on the several neurophysiological tools and their related strengths and weaknesses. It then got into several application areas of neurophysiological tools and how it can be utilized by neuromarketers.. The research topic had been presented based on three points: (1) Use and development of the systems. (2) Strategies and resultant business outcome, and (3) Decision support through group work.

In the study of Coulter, Zaltman & Coulter(2001), fourteen consumers were interviewed by using the Zaltman Metaphor Elicitation Technique. The study was conducted to understand consumer perception with regard to advertising. The metaphors used in the study showed that it provides information, entertainment. However, their study also showed that advertising has its own share of liabilities.

Getting out of the bandwagon, Morin(2011) with a different point of view, theoretically discussed in his paper, the concept of neuromarketing in details.He

also described regarding how neuromarketing can help in enhancing effectiveness of both cause related and commercial advertisements.

Alast but not the least, consumer neuroscience is now spreading its tentacles in luxury retailing. As per neuromarketers, it's necessary to study brain responses with regard to a luxury product to a simple branded product. As per social facilitation theory and utilizing electroencephalogram methods, Pozharliev(2015) studied the events of luxury purchase when female participants were given basic and luxury branded products to view passively. The results showed that the presence of a person enhances the emotional appeal of both a luxury brand as well as a basic brand.

### VIII. MARKETING

Practitioners for long have been studying on branding and how it can be used for lots of benefits like differentiation, competitive advantage, providing customer value and high quality of service. Very less studies have taken place considering cross culture, anthropology and neuromarketing. These days companies are taking help of neuromarketing for entry into markets. Thus, the analysis of Lukac & Schafer(2010) will prove to be handy as they studied on the entry of Deutsche Telekom in Serbia and Croatia. Their study considered both the cultural as well as neurological aspects of customers. A similar study was also carried out by Nemorin(2017) with special focus on "animalization of thinking".

Chen(2007) also studied about how neuroscience can be applied in better marketing performance. He carried out his study based on Gini Index, Decision Tree, Bayesian classification. These analysis help in identification of profitable customers. Based on the R-F-M (recency, frequency, monetary amount) concept, further calculation can be done on the customer lifetime value and marketing profit.

Though a good number of studies have dealt with how brand perception and price influence consumer behaviour, but very few studies have delved into the placebo effects of marketing. In their study Plassmann & Weber(2015) studied on the individual differences of placebo effects of marketing as received from behavioural and brain imaging experiments. The experiments show that consumers with high needs of cognition can be influenced more effectively with marketing placebo than reward seeking ones.

On the other hand, Gang et al.(2012) carried out a general study on neuromarketing through review of scholarly articles drawing relation between neuromarketing and perceived quality, price, brand, consumer buying decision, services marketing and product management. They also discussed on the advantages and disadvantages of fMRI and future path of neuromarketing.

In order to study brand choice, response latency neurophysiological activation, with regard to familiar and novel brands, Reimann et al.(2012) carried out two experiments. Their results pointed out that (1) Positive moods lead customers to choose novel brands over familiar brands (2) Novel brands are related to longer choice timing than familiar brands (3) An fMRI study proved that ventro medial prefrontal cortex and cingulate gyrus play a big role in the comparison between novel and familiar brands.

Since the 1890s, though psychophysiological devices have played a big role in marketing and consumer research still their mentioning have been less in literature. But these devices had always been significant in marketing research. Thus, Schwarzkopf(2015) in his study had done a post human view of the genealogy of neuromarketing.. He concluded that for researchers, neuromarketing has opened up a great path of bypassing verbalized cognition of consumers rather introspecting into their physiological reactions. Mentionably, Jain et al.(2018) carried out a study on the real time applications neuromarketing based on EEG signal classifications.

Sensation takes place when the stimulus puts an impact on a sensory organ's receptor cells. Sensation is both neurological and biochemical in nature. Time and again experts are telling that in order to become successful a brand has to appeal to the senses of consumers. That's why Krishna(2012)in her paper gave an integrative view of sensory marketing – marketing that appeals to senses of consumers. Based on literature review she had put down the elements of sensory marketing. The elements are haptics, smell, audition, taste, consumption and satiety. Thus, all neuromarketers must keep the above elements in mind in order to have a top of the mind recall among customers.

In order to bring a new direction in current studies on neuromarketing, the study of Cerf et al.(2015) introduced the concept of single neuron recording for consumer and marketing researchers. In the first stage the authors gave a detailed account of different aspects on single neuron recording. In the second stage, they pondered upon its relevance and its application in areas like experience recall, sensory differentiation between familiar and novel brands and categorization. Lastly, they showed regarding how single neuron study data are collected and analysed. They also showed that firing rate of neurons increase with emotion enhancement.

Lastly, Lim(2018) discussed the ways through which neuromarketing can be applied in business-to-business (B2B) marketing. Through their discussion they also detailed the frontiers and boundaries with regard to B2B marketing. Insights have been shared regarding what neuromarketing can and cannot do for B2B marketing. Lastly, it can be concluded that his article did answer a good number of questions related to neuromarketing and B2B marketing.

## IX. ADVERTISING

Neuromarketing has also got its application in advertising world. Now, what are studies saying in this regard?

Daugherty, Hoffman & Kennedy(2016) in their research introspected about advertisements and their impact on customers. They did it based on EEG studies.

On the other hand Venkatraman et al.(2015)used an experimental framework to understand the effectiveness of current neurological methods currently used to study marketing phenomenon. They studied the effectiveness of different neurological tools namely, functional magnetic resonance imaging, electroencephalography, biometrics, eye tracking, implicit measures and traditional self-reports. The authors showed that the tools effectively capture higher level constructs of advertising research in terms of desirability, memory, affect and attention with functional magnetic resonance imaging can show the best variance in advertising elasticity over and above traditional methods.

Lastly, Craig et al.(2012) through primary functional magnetic resonance imaging data studied how consumers differentiate between an advertisement as deceptive or trustworthy. They wanted to study the cognitive mechanisms behind such a study. They found out activations at two stages namely precuneus activation; temporal-parietal and superior temporal sulcus junction activation. They also found that brain activities are more in case of moderately deceptive advertisement rather than the highly deceptive ones.

## X. PRICING

Price plays a very important role in consumer decision making. Consumers generally evaluate the worth of a product based on price and associated features. Karmarkar, Shiv & Knutson(2015) studied the factor of price primacy by analysing functional magnetic resonance imaging of the prefrontal cortex. The authors found that respondents evaluate a product fully based on its attractiveness or features. But when price is shown to them beforehand, they then evaluate the total worth of the product along with the price. Thus, it was proved that if worth is rightly determined, price primacy can play a major role in overall consumer decision making.

On the other hand, Berns(2005) carried out a detailed literature review on pricing, placebo and brain. He gave a brief account of placebo of the brain by analysing 15 scholarly articles.

Lastly, Shiv, Carmon, and Ariely (2005) showed through detailed advertisements that price paid for a beverage not only affects the perceived benefit but also acts positively in terms of placebo effects.

## XI. SALES MANAGEMENT

After application of neuro science in marketing, advertising, pricing the next thing it's getting applied is sales management. Infact marketers are exploiting neuro science in a big manner to appeal more effectively before customers.

McClaren(2013) carried out a comprehensive literature review of scholarly articles related to personal selling and sales management. There he discussed regarding how neuromarketing tools can be effectively used by salesmen for better productivity by considering the studies of Ariely & Berns(2010) and Gountas & Ciorciari(2010).

Nickels, Everett & Klein(1983) did one of the earliest studies related to neuromarketing by showing that how salesmen could perform better if they combine neuro linguistic tools along with their selling skills.

## XII. OTHER STUDIES

Some studies conducted on various other areas connecting neuro marketing as per the below:

A breach of trust is always a significant event given the strength of relationship. In their study, Schilke, Reimann & Cook(2013) tried to find a key feature of relationship that impacts trust recovery and the spread of relationship before trust breach. The study found that stronger relationship before trust breach helps in trust recovery. They proved it through neuroimaging study of activations of the brain. The lateral frontal cortex and anterior cingulate cortex plays significant roles in the whole process behind relationship, trust breach and trust recovery.

These days, neuro marketers are implementing remote sensing technologies in order to study about different habits and decision process of customers. Nemorin & Gandy(2017) intends to study the impact of neuro marketer's reliance on direct and indirect forms of remote sensing. The data generated through functional magnetic resonance imaging(fMRI), analysed through machine learning techniques enables companies to carry out proper market segmentation, targeting and positioning.

In their paper, Schneier & Woolgar(2012) drew attention to the fact that how neuromarketing reveals a certain part or version of a customer. The revelation reflects what is actually the case, the reason of their selection of one product/brand over another and what is the hidden case, the other side which customers don't reveal.. This contrast is the main essence of their study.

Last but not the least is the fact that the concept of neuromarketing is even revolutionizing the world of economics. Economics is the discipline with deals the satisfaction of unlimited needs and wants with limited resources. With this aim in mind, certain factors like choice under uncertainty, strategic choice need to be kept in mind. From economics with the combination of neuroscience two hybrid concepts have emerged in the form of "Psycho economics" and "Neuro economics".

Psycho economics deals with the observations carried out on mental processes responsible in consumer decision making. It deals with mental states that gives shape for giving birth to a decision. Neuroeconomics on the other hand study brain imaging to understand the functioning of brain with regard to buying decision. It also studies the different activations of brain leading to the final purchase decision. In her paper, Walliser(2012) discussed on the epistemological issues of these two disciplines.

### XIII. ETHICAL ASPECTS OF NEUROMARKETING

Neuromarketing has definitely a good number of plus points. Since its arrival, marketers are utilizing it for great benefits. Infact due to neuromarketing, marketers are getting great insights into the thought process of consumers. But there are also ethical aspects of neuromarketing which have been justifiably shown in different studies. Researchers fear that with the help of neuromarketing, marketers can have a “Buy” button to click right in the brain of consumer which is alarming. So studies need to be discussed in this regard.

Lindell and Kidd(2013) showed that marketers of educational products use neuro marketing related names for their products even though their intrinsic value is not so much. Terms related to brains are intentionally used to attract customers. Unnecessarily they also put brain images on the product packages to enhance scientific rationale. Thus this is one way of manipulating the customers.

Stanton, Armstrong & Huettel(2017) did a more detailed study with regard to ethical aspects of neuromarketing. Based on other studies and their own findings, they listed a detailed account of common ethical concerns of customers and also the ethical questions faced by companies. The ethical concerns of consumers are regarding marketer’s increasing ability in prediction(Smith et al., 2010; Soon et al., 2013; Telpaz et al. 2015) and influence (Ferraro et al., 2009; Durante et al., 2011; Duhigg, 2012; Saad and Stenstrom, 2012; Clithero and Rangel,2013; Durante and Arsena, 2015) of consumer choice, privacy(Murphy et al., 2008), increase in price (Plassmann et al., 2008), fuelling of consumerism, lack of transparency with regard to taking consent(Kelly 2013; Kramer et al. 2014).

In another study, Wilson, Gaines & Hill(2008) examined the connection of neuromarketing with consumer freewill. Thus they studied the ethical aspects of hurting consumer privacy. For this study they emphasized on the understanding, consent and awareness of consumers.

### XIV. CONCLUSION

The paper carried out an in depth study of scholarly articles on neuromarketing. Through literature

review, it attempted to give a detailed account of different aspects of neuromarketing as happening in the current world. From introduction, theoretical framework the study goes on discussing in details about methodology, basic concept of neuromarketing, history, practical implementations, to the different areas of research done on the topic namely in consumer neuroscience, marketing, advertising, pricing, sales management, miscellaneous topics and lastly ethical aspects. Though neuromarketing is growing at a huge pace, getting very popular as days are passing but one can’t deny its ethical aspects. Future researchers must carry out study on the human brain as per scientists, Man has been able to study only 20% of the human brain. More needs to be studied. Also future studies must get into indepth analysis regarding the ethical pitfalls of neuromarketing. Corporates must also come forward in these studies as neuromarketing holds great potential. The main objective of corporate research should be to see how more insights can be gained without harming consumer privacy.

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