COGNITIVE RESPONSE TO THE DISPLAY DESIGN OF AUTO DEALER'S ADVERTISEMENT – A STUDY OF NEUROMARKETING PERSPECTIVE

By

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TINDAK BALAS KOGNITIF TERHADAP PAPARAN REKA BENTUK IKLAN AUTOMOTIF – KAJIAN PERSPEKTIF "NEUROMARKETING"

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Tesis diserahkan untuk memenuhi sebahagian keperluan bagi

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LIST OF ABBREVIATIONS

ERP	Event Related Potential
EEG	Electroencephalography
US	United States
UK	United Kingdom
fMRI	functional Magnetic Resonance Imaging
CNS	Central Nervous System
ANS	Autonomic Nervous System
SNS	Somatic Nervous System
ms	Miliseconds
MRI	Magnetic Resonance Imaging
PET	Positron Emission Tomography
MEG	Magnetoencephalography
USM	Universiti Sains Malaysia
ISI	Inter-Stimulus Intervals
sec	Seconds
GSN	Geodesic Sensor Net
VRG	Vertex Reared Grouped
VFG	Vertex Frontal Grouped
RLS	Right Lateral Singular
LLS	Left Lateral Singular
RLG	Right Lateral Grouped
LLG	Left Lateral Grouped

MB	Megabyte
kB	Kilobyte
Ml	Millilitre
Cm	Centimetre
Hz	Hertz
SPSS	Statistical Package for the Social Science
.avi	Audio Video Interleave
ASCII	American Standard Code for Information Interchange
SD	Standard Deviation
SMI	SensoMotoric Instruments
BeGaze	Behavioural and Gaze Analysis Program
IDF	iView Data File
AOI	Area of Interest
mm	Millimeter

LIST OF SYMBOLS

$	Dollar sign
%	Percentage
α	Alpha
µV	Microvolt
<=	Less or equal than

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ABSTRAK

Kajian "Neuromarketing" adalah berbeza daripada kajian pemasaran konvensional kerana ianya tidak bergantung kepada laporan kendiri daripada subjek. Input daripada teknik-teknik "Neuromarketing" adalah daripada proses-proses yang berlaku dalam otak dan ini dapat menghapuskan introspeksi dan ego daripada subjek. Tugas komunikasi pemasaran dilakukan melalui pengiklanan. Pengiklanan merupakan salah satu teknik komunikasi daripada promosi yang paling berpengaruh. Oleh kerana kos pengiklanan yang tinggi dan pemasaran adalah perniagaan yang sangat kompetitif, pengiklan cuba memahami bagaimana iklan dapat menarik perhatian pelanggan dan memperbaiki iklan supaya dapat menarik perhatian pelanggan. Pengiklanan yang berkesan dapat menarik perhatian pelanggan dan sekali gus menyumbang kepada jualan produk. Kajian ini tertumpu kepada pengiklanan paparan reka bentuk yang dapat menarik lebih perhatian dengan mengukur tindak balas kognitif dan tingkahlaku pandangan. Seramai 15 subjek diambil daripada kalangan pelajar perubatan USM. Tindak balas kognitif semasa melihat paparan reka bentuk yang berbeza telah direkodkan menggunakan ERP. Amplitud dan "latency" yang membangkitkan komponen-komponen ERP N100, P200, N200 dan P300 telah dikenalpasti. Data amplitud dan "latency" telah dianalisis menggunakan "One-way ANOVA" dan data masa tindak balas dianalisis menggunakan "Independent t-test". Dua daripada 15 subjek yang menyertai rakaman ERP telah diambil menyertai rakaman "Eye Tracking" untuk mengukur tindak balas tingkahlaku pandangan

semasa paparan reka bentuk yang berbeza. Keputusan ERP dan tingkahlaku pandangan menunjukkan keputusan yang konsisten bahawa subjek memberikan lebih perhatian (17 daripada 19 tapak elektrod, menunjukkan min bagi amplitud N100 adalah lebih tinggi semasa paparan reka bentuk pandangan VRG berbanding "Neutral" [Empat tapak elektrod (FP2, F4, C4 dan T3) signifikan dan 13 tapak elektrod tidak signifikan]) kepada paparan reka bentuk pandangan "Vertex Reared Grouped (VRG)" berbanding "Neutral" dan pandangan " Vertex Frontal Grouped (VFG)" semasa sesi "Neuromarketing 1" dan lebih banyak perhatian (14 daripada 19 tapak elektrod, menunjukkan min bagi amplitud N100 adalah lebih tinggi semasa paparan reka bentuk pandangan RLG berbanding "Neutral" [Dua tapak elektrod (F7 dan C4) signifikan dan 12 tapak elektrod tidak signifikan]) kepada paparan reka bentuk pandangan "Right Lateral Grouped (RLG)" berbanding "Neutral" dan pandangan "Left Lateral Grouped (LLG)" semasa sesi "Neuromarketing 3". Kecenderungan amplitud yang tinggi daripada komponen-komponen ERP N100, P200, N200 dan P300 semasa paparan reka bentuk VRG dan RLG menggambarkan bahawa subjek mempunyai "visual selective attention", "visual searching perception", "visual identification task" dan "visual cognitive processing" yang lebih baik semasa pembentangan visual pandangan-pandangan tersebut. Tafsiran visual peta perhatian bersama-sama tempoh fiksasi dan saiz anak mata semasa tingkahlaku pandangan daripada data dua kajian kes menunjukkan bahawa pandangan VRG dan RLG lebih menarik perhatian berbanding pandangan berlawanan. Semasa sesi "Neuromarketing 2", keputusan ERP dan tingkahlaku pandangan menunjukkan bahawa subjek telah memberikan perhatian yang serupa semasa paparan "Right Lateral Singular (RLS)" dan "Left Lateral Singular (LLS)". Kecenderungan amplitud yang sedikit tinggi daripada komponen-komponen ERP N100, P200 dan N200

semasa paparan reka bentuk LLS menggambarkan bahawa subjek mempunyai "visual selective attention", "visual searching perception" dan "visual identification task" yang lebih baik semasa pembentangan visual pandangan LLS berbanding pandangan RLS. Corak taburan amplitud P300 bagi paparan reka bentuk pandangan LLS dan pandangan RLS adalah hampir sama, ini menunjukkan bahawa subjek mempunyai "visual cognitive processing" yang hampir sama semasa kedua-dua pandangan ini. Tingkahlaku pandangan daripada dua kajian kes menunjukkan bahawa semasa paparan reka bentuk pandangan RLS dan pandangan LLS, jumlah tatapan dalam kedua-dua pandangan adalah hampir sama dalam peta fokus dan peta haba. Warna sebagai tumpuan bersama kajian ini, data prestasi pandangan daripada dua kajian kes menunjukkan hasil dapatan keputusan yang menarik, dimana kedua-dua subjek menunjukkan minat yang sama terhadap warna perak semasa pandangan VRG, warna emas semasa pandangan VFG, manakala warna merah semasa pandangan LLG dan RLG. Ini menunjukkan bahawa warna juga memainkan peranan dalam paparan reka bentuk. Bagi menjimatkan kos dan mengoptimakan ruang pengiklanan yang terhad, pemasar dinasihatkan mereka bentuk iklan mereka berdasarkan daripada penemuan kajian ini. Antara pandangan VRG dan pandangan VFG, adalah dinasihatkan bahawa pemasar mengutamakan paparan reka bentuk pandangan VRG. Antara pandangan RLG dan pandangan LLG, adalah dinasihatkan bahawa pemasar mengutamakan paparan reka bentuk pandangan RLG. Dalam kes paparan reka bentuk pandanagan RLS dan LLS, pemasar boleh menggunakan mana-mana daripada dua paparan reka bentuk ini.

COGNITIVE RESPONSE TO THE DISPLAY DESIGN OF AUTO DEALER'S ADVERTISEMENT – A STUDY OF NEUROMARKETING PERSPECTIVE

ABSTRACT

Neuromarketing research is different from conventional marketing research as it avoids relying upon subjects self-report. Input from Neuromarketing tools are from processes happening in the brain and therefore eliminated introspection and ego from subject. Marketing communication task is carried through advertising. Advertising is one of the most influential communication tools of promotion. Advertisement costs high revenue and marketing is a very competitive business, advertisers have been trying to understand how advertisement works and to improve advertisement so that it ables to capture customer's attention. Effective advertisement that able to capture customer's attention would contribute to the selling of product. This study focused on which display design of advertisement that would be able to attract most attention by measuring cognitive response and gaze behaviour. Total of 15 subjects were recruited from USM undergraduate medical students. ERP as a cognitive response during viewing different display designs were recorded. The amplitude and latency of the evoked N100, P200, N200 and P300 ERP components were identified. Amplitude and latency data were analysed using One-way ANOVA test and reaction time was analysed using Independent t-test. Two out of the 15 subjects participated in ERP recording were recruited for Eye Tracking recording that measure the gaze behavioural response to the different display design. The result of the ERP and gaze behaviour showed consistent results that subjects were more (among 19 electrodes sites, mean N100 amplitude is higher in VRG view at 17 sites compared to Neutral [Four scalp sites (Fp2, F4, C4 and T3) significantly and 13 sites insignificantly]) attentive to the display design of Vertex Reared Grouped (VRG) view compared to Neutral and Vertex Frontal Grouped (VFG) view, and more (among 19 electrode sites, mean N100 amplitude is higher in RLG view at 14 sites

compared to Natural [Two scalp sites (F7 and C4) significantly and 12 sites insignificantly]) attentive to the display design of Right Lateral Grouped (RLG) view compared to Neutral and Left Lateral Grouped (LLG) view in Neuromarketing session 1 and Neuromarketing session 3 respectively. The tendency of higher amplitude of N100, P200, N200 and P300 ERP components for display design of VRG and RLG view reflected that subjects had greater visual selective attention, visual searching perception, visual identification task and visual cognitive processing during visual presentation of these particular views. Visual interpretation of attention map together with fixation duration and pupil size of gaze behaviour data from two case studies revealed that VRG and RLG view attracted more attention than its counterpart. For Neuromarketing session 2, the results of the ERP and gaze behaviour showed that subjects were equally attentive to display design of Right Lateral Singular (RLS) view and Left Lateral Singular (LLS) view. The tendency of marginally higher amplitude of N100, P200 and N200 ERP components for display design of LLS view reflected that subjects had better visual selective attention, visual searching perception and visual identification task during visual presentation of LLS view as compared to RLS view. The pattern of P300 amplitude distribution for display design of LLS view and RLS view were almost similar which reflected subjects' similar visual cognitive processing. Gaze behaviour from two case studies showed that focus map and heat map during display design of RLS view and LLS view indicated the amount of gaze received in these view was similar in both display design. With regards to colour as a confounder, gaze performance data from two cases opened an interesting finding is that both subjects showed common interest in silver and gold colour at VRG and VFG view respectively but red colour in both LLG and RLG view, indicating colour may play a different role in display design. For cost-effective and limited space advertising, marketers could design their advertisement based on the findings from this study. Between VRG view and VFG view, it is advisable that marketers prioritize display design of VRG view. Between RLG view and LLG view, it is advisable that marketers prioritize display design of RLG view. In case of display design of RLS view and LLS view, marketers could use any of these two display designs.

CHAPTER 1

INTRODUCTION

1.1 Background of the study

1.1.1 Marketing and advertising

The heart of every business model are marketing and advertising. According to American Marketing Association (2013), Marketing covered a set of establishments and practices that generate, communicate, provide and deliver products and services that have value to the customers in particular and society in general. Marketing world is synonym with marketing mix which incorporates the coordination of 4P's. These 4P's are product, promotion, price and place. Marketing mix is the controllable factors of marketing tools that affects the demand for the product and increase it (Gibbs *et* al., 2008; Singh, 2012).

The coordinated elements of marketing mix established effective influence over customers. In marketing, the decision related to the marketing mix is the most important as it contributes to the success of achieving goals of sales and profitability. Decision related to advertising directly reflected promotion aspect of marketing mix. Advertising, sales promotion, public relation, sales force and direct marketing are communication tools of promotion that function to deliver messages to the target customer. Out of all the communication tools of promotion, advertising is the most influential tool in the identification of company, product, service or idea (Rad *et* al.,

2014). Communication task in marketing is mostly carried through advertising. Hence, this illustrates the significance role of advertising in marketing and business world. Studies in marketing demonstrated that productive advertising generates immediate impact on sales and determined not only the size of the impact, but also the duration of impact as well (Mela *et* al., 1997; Hanssens, 2011).

Advertising is well known as the most powerful tool. It involves large allocation of budget. Advertising expenditure globally in 2015 was $592.43 billion with US leading the rank with expenditure of $189.06 billion. China was at the second rank with expenditure of $73.13 billion. Japan was at third rank with expenditure of $40.19 billion. Germany was at fourth rank and UK was at the fifth rank with expenditure of $27.71 billion and $25.22 billion respectively. US, China, Japan, Germany and UK were listed as the top five countries with highest expenditure for advertising through data from eMarketers as shown in Table 1.1. Total media in advertising includes the entire advertising medium such as newspaper, radio, television and magazine.

Table 1.1: Top five countries with highest expenditure in advertising

Country	Total Media
1. US	$ 189.06
2. China	$ 73.13
3. Japan	$ 40.19
4. Germany	$ 27.71
5. UK	$ 25.22
Worldwide	$ 592.43

Source: eMarketers, 2014

1.1.2 Automotive industry

Automotive industry is one of the industries that spends large amount of budget on advertising. Automotive industry is the industry which deals in business of vehicles. Automotive industry spent $6.4 billion in 2011, $7.2 billion in 2012 (National Automobile Dealers Association, 2013) and $7.6 billion in 2013 (National Automobile Dealers Association, 2014). In Malaysia, $4.2 billion was spent in 2014 for advertisement and 9% ($0.38 billion) from this budget was for automotive advertising (iCarAsia Limited, 2015). General Motor is one of the companies in automotive industry that spent large expenditure on advertising. This company spent $3.1 billion for advertisement. While, Fort Motor spent $2.5 billion and Fiat Chrysler Automobiles spent $2.2 billion respectively on advertising (O'Reilly, 2015).

Automotive industry is a complex and competitive business as it takes several years to develop a product. Henceforth, it is not surprising that this industry spends large expenditure on advertising to build product awareness and create identity within the market so that the product can be sold and gain profit. In addition, there is always significant competition within this industry. Therefore, this industry needs to ensure that their products stand out.

Although each year billion dollars are invested in advertising, conventional marketing to predict the effectiveness of advertisement has many flaws as it depends on the willingness and capability of subjects to describe their thoughts and emotions as they are being exposed to advertising (Lee *et* al., 2007; Morin, 2011). People assume that they are capable to describe their cognitive processes. While in actuality, individuals are unable to self-assess and self-report as they are often not aware of the

reason for them as cognitive processes have subconscious components. Moreover, as individuals have no desire to participate, they have high inclination to transmit incorrect information especially when the topic is very sensitive or when they feel the need for social acceptance. Therefore, the responses obtained are not genuine as they are filtered by the individual's consciousness before it is being reported (Hubert & Kenning, 2008).

Methods such as focus group, preference questionnaire, simulated choice method and market test that are commonly used by conventional marketing harvest subjective data which do not carry the same level of accuracy as in Neuromarketing, where in Neuromarketing subjects does not have control over the information collected (Fugate, 2007; Hubert & Kenning, 2008; Butler, 2008; Ariely & Berns, 2010). Neuromarketing offers several indicators that can measure effectiveness of the advertisement. Emotional engagement, memory retention, purchase intention, novelty, awareness and attention are some of the effectiveness indicators that can be measured through Neuromarketing (Sebastian, 2014). In contrast to the conventional marketing methods such as survey, focus group and qualitative research, the significance of Neuromarketing lies in it access to richer and less biased marketing insights (Hubert & Kenning, 2008; Murphy *et* al., 2008; Eser *et* al., 2011; Page, 2012).

1.1.3 Neuromarketing

The hybrid between Neuroscience and Marketing gives rise to the becoming commonly field known as Neuromarketing. Advancement in Neuroscience

knowledge and technique has been applied into marketing to help further growth of marketing. Neuromarketing falls into one of the divisions in the broad field of Neuroeconomics. An interdisciplinary field of Neuroeconomics combines sub-field such as Economics, Neuroscience and Psychology to study the brain function in processes such as decision making (Kenning & Plassmann, 2005; Lee *et* al., 2007; Hubbert & Kenning, 2008; Garcia & Saad, 2008; Page, 2012). The word 'Neuromarketing' was first coined by Professor Ale Smidts in 2002. However, the history of Neuromarketing can be traced back to 1990's as fMRI was used as marketing tool by Gerry Zaltman (Lewis & Bridger, 2005).

In general, Neuroscience is known as the field that is interested in exploring knowledge related to the structure and function of the brain. Cognitive Neuroscience, sub-division of Neuroscience focused on the neural mechanism behind mental processes such as perception, attention, memory, reasoning and decision making. The knowledge from Neuroscience when applied in marketing would help in notions of positioning, hierarchy of effects and brand loyalty (Perrachione & Perrachione, 2008). The main purpose of Neuromarketing is to assess customers' cognitive and emotional responses to various marketing stimuli (Karmarkar, 2011). Neuromarketing has allowed researchers to tap into the mind of customers and measures cognitive and emotional responses as they mentally respond to the marketing stimuli.

Neuromarketing is considered as the state-of-the-art form of marketing study and practice as it incorporated the use of Neuroscience methods. Marketers are shifting from conventional marketing to Neuromarketing as Neuroscience methods

capable to go deeper to the underlying biological and chemical process which provides a better view of psychological and behavioural processes (Hubert & Kenning, 2008). Factors that affect decision making and influence behaviour are perceived unconsciously. Therefore, it is impossible to describe them verbally.

Moreover, conventional marketing is commonly constructed on self-assessment measures which rely on the ability and willingness of the subjects to report their attitude, behaviour or emotion which were less powerful and explanatory than once predicted (Fugate, 2007). Subjects may feel ashamed or ego to truthfully report how they feel or think. Information that subjects has reported may be unreliable as they reported half-truth or edited their thought. Apart from that, in Neuromarketing subjects cannot be biased or influenced the result as they have no or little influence over the measurement of brain activity (Hubert & Kenning, 2008). Physiological responses can be collected at the moment of the experience instead of conventional marketing methods where results were obtained after the stimulus (Lee *et* al., 2007).

Measurement of physiological processes in Neuromarketing has allowed researchers to understand the relationship between behaviour and physiological processes that take place in the brain. Generally, the measurements are classified into three categories which are Central Nervous system (CNS) measure, Autonomic Nervous System (ANS) measure and Somatic Nervous System (SNS) measure.

The CNS measure consists of non-hemispheric brainwave analysis, hemispheric lateralization and brain imaging analysis while the ANS measure

consists of pupillary response, electrodermal analysis, voice pitch analysis, heart rate response and vascular activity. Lastly, the SNS measure consists of facial muscle activity and eye movement analysis (Wang & Minor, 2008). In this Neuromarketing study, ERP was used for brain imaging analysis and Eye Tracking for eye movement analysis.

1.1.4 Event Related Potential (ERP)

Electroencephalography or more commonly known as EEG is a non-invasive tool which is capable of capturing and recording the electrical signals produced by brainwaves' activity through the use of electrode sensors on the scalp (Sebastian, 2014). An event related potential is the measured brain response that is the direct result of a specific sensory, cognitive or motor event (Otten & Rugg, 2005; Luck, 2005). ERP are EEG changes that were time-locked to events such as sensory, motor and cognitive. It is called event-related as ERP occurred as a consequence of an event or stimulus. ERP is a voltage fluctuation within EEG that is time sequenced to a specific event (Patel & Azzam, 2005; Treleaven-Hassard *et* al., 2010).

Characteristically, there are two kinds of evoked potential in ERP which are categorised as exogenous and endogenous. Exogenous potential reflected the first neural processing of the physical characteristics of a stimulus and the magnitude of the response is not dependent on the cognitive processing of the stimulus. While endogenous potential elicited in complex experimental situation and usually required active participation of subject. Exogenous represented the sensory responses evoked by the stimulus and able to be recorded without any consciousness from the subject

whereas endogenous involved higher cognitive processes such as attention and memory.

Underlying ERP components are related to the ERP waveforms which consist of a series of positive and negative voltage deflections. Nomenclature of ERP components are mostly categorised by a letter N or P which indicates negative polarity (N) and positive polarity (P). Nomenclature of ERP components are then followed by a number indicating either the latency in milliseconds or the component's ordinal position in the waveform. ERP components are measured by the peak latency which measured in milliseconds or by peak amplitude which measured by microvolts (Treleaven-Hassard *et* al., 2010).

1.1.4.1 N100 ERP component

N100 or also known as N1 is a negative deflection that peak between 90 and 200ms after the onset of stimulus. N100 is typically observed after presentation of an unexpected stimulus. It is an orientating response or matching process in which whenever a stimulus is presented, it is matched with previously experienced stimulus (Sur & Sinha, 2009).

1.1.4.2 P200 ERP component

P200 or also known as P2 is a positive deflection that peak 100 to 250ms after the stimulus. There are possibilities that it reflected the sensation-seeking behaviour (Sur & Sinha, 2009). P200 represented some aspect of higher-order perceptual processing which modulated by attention. It is known that the P200 is typically elicited as part of

the normal response to visual stimuli and had been studied in relation to visual search and attention, language context information, memory and repetitive effects.

The P200 may be part of cognitive matching system that compared sensory inputs with stored memory (Freunberger *et* al., 2007). Some evidence indicated that the P200 may reflect general neural processes that occur when a visual input is compared with an internal representation or expectation in memory or language context, although the exact function and neural source is not yet known (Evans & Federmeier, 2007).

1.1.4.3 N200 ERP component

N200 or also known as N2 is a negative deflection that peaks 200 to 350ms post-stimulus and is found primarily over anterior scalp sites. N200 negativity is caused by a deviation from preceding stimuli. The N200 typically is evoked before a motor response, suggesting its link to the cognitive processes of stimulus labelling and distinction.

Past research focused on the N200 as a mismatch detector, but it has also been found to reflect executive cognitive control functions and has recently been used in the study of language (Folstein & Van Petten, 2008). N200 have three components which are N2a, N2b and N2c. The N2a is evoked whether subjects pay attention to or ignore the stimulus (Patel & Azzam, 2005). On the other hand, N2b and N2c are elicited only when attention is required. All subcomponents of N200 evoked by auditory stimuli showed a frontocentral or central scalp distribution

whereas N2c has posterior scalp distribution in the visual modality (Patel & Azzam, 2005).

1.1.4.4 P300 ERP component

P300 or also known as P3 is a positive deflection that peak around 300ms after the presentation of the stimulation. In general P300 reflected cognitive processing and particularly reflected working memory processes (Polich, 2003). P300 amplitude indicated stimulus information where greater attention produced larger P300 wave while P300 shorter latency indicated superior mental performance (Sur & Sinha, 2009). Generally, P300 response is divided into two subcomponents which are P3a and P3b. P3a is an early attention process that is generated by a frontal working memory representational change (Polich, 2007). P3b has been suggested to indicates memory storage as well as serving as a link between stimulus characteristics and attention (Patel & Azzam, 2005).

1.1.5 Eye Tracking

Eye Tracking is a tool for visual attention analysis and it seeks to associate visual attention with cognitive and emotional responses of customers (dos Santos *et* al., 2015). Eye Tracking enables researcher to observe subjects' visual behaviour as they perceived advertisement and observed the way the advertisement influence subjects' attention and cognitive processing.

In Eye Tracking, high-speed camera is used to precisely record a subject's gaze to assess visual attention. These cameras are mounted on a flat surface or are worn by the subjects. Eye Tracking is equipped with capability in measuring focus of customers' attention, the pattern of visual behaviour of fixations of the gaze, dilation of the pupils and focus (Vidal *et* al., 2012; Fortunato *et* al., 2014; dos Santos *et* al., 2015).

Eye movements are considered as good behavioural candidates for measuring visual attention. Eye movement measured the number of fixations or the dwell time of the eyes during introduction to stimuli. Eye movements are believed to be related to attention, memory and information processing. For example, the number of fixations per second was used in studies as an accurate indicator of attention to advertising, where higher number of fixations indicated higher attention (Wang & Minor, 2008).

Apart from that, Eye Tracking measures the size of the pupil or pupil dilation. Longer pupil dilation would correspond to the subject's better processing of the information (Sebastian, 2014). The measurement of the pupils was concurred with the areas and the frequency of observation that the subject spent focusing on the presented stimuli.

1.2 Literature Review

1.2.1 Neuromarketing

Neuromarketing is the new approach towards marketing. Marketing is defined as social and managerial process by which individuals and organizations obtained what they need and want through creating and exchanging products and value with each other (Kotler & Keller, 2008). The foundation of marketing field incorporated of advertising, selling and distribution. The emergence and application from other field such as Neuroscience, Psychology, Social Science, Economic, Sociology and Mathematic had evolved marketing towards tremendous growth.

Marketing world revolves around marketing mix which is the controllable factor of marketing tools. One of the important factors from marketing mix is the promotion. Advertising is one of the important components of the promotional mix where billions of dollars were spent every year on advertising (Kumar, 2015). Promotion or advertising function as a key roles to attract customers' attentions towards the product so that customers aware of the product and increase the probability of sales. However, marketing is facing challenges due to the declining power of advertising and rising competition among products (Engel *et* al., 1995).

1.2.1.1 Drawback of conventional marketing

Even though, over $40 billion dollars was spent each year in advertising, conventional marketing methods to predict effectiveness of investments showed weaknesses as it depends on the willingness and capability of customers to describe how they feel when exposed to advertising (Morin, 2011).

Conventional marketing method that rely mostly on subject self-reports had indicated flaws as people assumed that they are able to describe their own cognitive processes which are well known that cognitive processes have many subconscious components. For example, market research was conducted at Campbell in 2005 to assess the effectiveness of Campbell soup's advertising efforts and their influence on the purchase decision of customers. The company was surprised when they discovered that the company's advertisements were never actually effective in generating sales even when the surveys conducted indicated that there was relevant finding between the advertisement and the effectiveness of the advertisement.

They discovered that the customers did not think much about Campbell soup and also found out that their buying instinct was dying down whenever they saw a Campbell product at the supermarket. The company then decided to use Neuromarketing techniques to uncover the factors that prompt customers to decide on buying a soup, so that they are able to come out with a new label design that is capable to enhance the sale of the soup. Campbell redesigned its labels from the findings found through Neuromarketing and had gain increased in their sales (Kumar, 2015).

1.2.1.2 Advantages of Neuromarketing

Neuromarketing is a division of the general field of Neuroeconomics, which is an interdisciplinary field that combines Economics, Neuroscience and Psychology, to study the function of the brain in decision-making situations (Kenning and Plassmann, 2005). Neuromarketing is the new branch of marketing that makes use of

Neuroscience technology to determine a customer's internal subconscious reaction to products and brand names in order to plan effective marketing strategies.

Based on the resultant techniques derived from Neuroscience better identification and understanding of cerebral mechanisms fundamental to customer's behaviour is possible. This is helpful in the prospect of increasing the efficiency of the advertisement. The potential of Neuromarketing in reducing marketing failures and increasing marketing successes seems to be quite positive. Neuroscience techniques enable researchers to obtain information about human brain's response to marketing stimuli without simply relying on subjective reports given by the subject (Renvoisé & Morin, 2005).

1.2.1.3 Application of Neuroscience techniques in Neuromarketing

Previous researches in Neuromarketing had applied Neuroscience techniques such as fMRI, MRI, EEG, ERP, MEG, PET, Galvanic skin response, heart rate response and Eye Tracking. fMRI technique measured the brain's activity by detecting the oxygen level in blood flow. More oxygen required by the brain area that is more active. The advantage of this technique is its ability to measure deeper and smaller structures of the brain with high spatial resolution. However, this technique required a delay of 6 to 10 seconds to record the processing of neurons, which represents a great disadvantage with respect to several marketing stimuli because these numbers constitute low temporal resolution (Ariely & Berns, 2010). While MRI helps in understanding the manner in which the human brain interprets processes and understands messages transmitted by the advertising content.

EEG/ERP measured and recorded the electrical activity of the brain. This technique place electrodes on scalp to measure the electrical activity associated with different states of stimuli with capacity of measurement at small intervals up to 10,000 times per second (Morin, 2011). Advantages of this technique included less invasive, cheaper, portable, synchronisation with the stimuli and presents greater validity in the measurement of emotional styles and the detection of psychopathologies (Allen & Kline, 2004). However, this technique can only recorded more superficial electrical signals. Hence, cause low spatial resolution.

Positron emission tomography (PET) is technique with validity and spatial resolution similar to those of fMRI. However, radioactive particles must pass through the subject. Therefore, it is highly invasive and difficult to use in Neuromarketing (Lin *et* al., 2011).

MEG (Magnetoencephalography) technique measured the magnetic field created through neural activities and electrochemical signals between neurons. MEG has excellent temporal resolution. Its spatial resolution, while not ideal for measuring subcortical areas and deeper areas in the brain, its is superior to that of EEG (Morin, 2011). However, the cost of the acquisition of the necessary equipment and MEG session is very expensive (Crease, 1991).

Galvanic skin response measured the changes in the electrical properties of the skin depending on the level of moisture. This technique measured the objective excitation caused by an emotionally relevant stimulus. The central nervous system is directly connected to the reactions recorded on individuals' hands and this method is

able to identify the neural responses that precede certain emotions (Banks *et* al., 2012).

Heart rate technique recorded the heart rate and its variability, blood pressure, interaction between hearts beats and pulse transition time to infer emotional and attention states of the research subjects (Fortunato *et* al., 2014).

Eye Tracking technique is increasingly used along with other techniques such as EEG/ERP and fMRI. Advantages of this technique is it capability to measure the focus of customers' attention, the pattern of visual behaviour of fixations of the gaze, dilation of the pupils and focus. The time that the subject spent focusing on the object of study, the measurement of the pupils, the areas and the frequency of observation in the stimuli presented were data of interest in marketing achievable through this technique (Fortunato *et* al., 2014). In this study, ERP and Eye Tracking were used.

1.2.2 Techniques in Neuromarketing - ERP and Eye Tracking

1.2.2.1 ERP technique

Neurons in the brain communicate with each other through firing rhythms of electricity. As millions of neuron sending signal at once, they produced massive amount of electrical activity in the brain which could be detected over the area of the scalp using device such as Event Related Potential (ERP). ERP are voltage fluctuations derived from on-going Electroencephalograph (EEG) induced within the brain that are time-locked to sensory, motor or cognitive processes (Friedman &

Johnson, 2000; Friedman *et* al., 2001; Kuperberg, 2008). EEG measure electrical signals generated by the brain through electrodes placed on the scalp.

Generally, gel or a conduction solution is used to connect the electrodes to the scalp. Electrodes on the scalp measured the voltage fluctuations resulting from electrical activity in the brain. The baseline activity is then averaged out, leaving just the electrical responses evoked by each stimulus presentation. ERP or time-locked EEG capable to capture very small voltages generated in the brain in response to specific event or stimuli.

ERP method is a non-invasive, direct measure of the electrical activity in the brain recorded through the scalp at the time of response which leads to excellent temporal resolution. Temporal resolution in neuroimaging methods such as fMRI and PET is in terms of seconds whereas methods such as MEG and ERP, the temporal resolution is in terms of milliseconds (Swick *et* al., 1994; Zani *et* al., 2003). This excellent temporal resolution allowed a temporally detailed investigation of the processes underlying cognitive functions where early components reflect sensory processing and later components reflect higher-level cognitive processes (Woodman & Luck, 2003).

In addition, ERP provided a measure between stimulus and response which allow the better understanding of the effects of precise experimental manipulations. Apart from that, ERP became the highlight in many researches compared to the other brain imaging methods as ERP involved simple recordings of electrical potentials

produced by the brain without experimentally introduced perturbations of the cerebral regions.

ERP comprised of a series of successive positive and negative deflections that are often referred to as ERP components. In general, these components were categorised into two which are exogenous and endogenous. The early components known as exogenous depend largely on the physical parameters of the stimulus and peaking roughly within the first 100 milliseconds after stimulus. In contrast, later components or known as endogenous reflected the manner in which the subject evaluates the stimulus and as they examine information processing (Sur & Sinha, 2009). Amplitude, latency and scalp distribution were three measurable features of ERP component (Johnson, 1989; Friedman & Johnson, 2000). Amplitude provided an index of the extent of neural activation where it explains how the component responds functionally to experimental variables. Latency provided the timing of this activation. The scalp distribution provided information on the overall pattern of activated brain areas. This study applied four ERP components which were N100, P200, N200 and P300.

The capability to record from high-density electrode arrays in human subjects through 128–256 electrode channels has provided substantially better spatial resolution for mapping information flow between the multiple cortical areas that sub-serve perception and cognition (Potts *et* al., 1998; Foxe & Simpson, 2002). This progress in ability to separate spatially overlapping activation topographies on the scalp gives more thoroughly opportunity to exploit the temporal resolution of the ERP method. Excellent temporal resolution and improved spatial resolution of ERP method has allowed exploration within the network of functional cortical areas by

examining finer topographic transition on the scalp surface through millisecond by millisecond and sufficiently able to differentiate cortical activations at the level relevant to many fundamental neuroscience issues.

Studies have found visually responsive neurons that are distributed beyond cortical areas which typically described as directly involved in vision which includes areas such as premotor cortex, supplementary motor area, dorsolateral prefrontal cortex and frontal eye fields. Given these findings, visual stimulation would be expected to result in activation of human frontal cortex (Saron *et* al., 2001).

The N100 ERP component is typically observed after presentation of unexpected stimulus. It is an orientating response or matching process in which whenever a stimulus is presented, it is matched with previously experienced stimuli (Sur & Sinha, 2009). One of the studies specifically tested the hypothesis that the N100 component reflected the operation of a discriminative process (Luck, 1995; Vogel & Luck, 2000). The findings indicated that N100 attention effect appears to reflect a relatively pure enhancement of attended-location stimuli, where N100 amplitude is greater for attended-location stimuli compared with stimuli presented under neutral or distributed attention conditions (Luck *et* al., 1994; Luck & Yard, 1995; Vogel & Luck, 2000).

Apart from that, the findings indicated that N100 attention effect appears to be found only when subjects are required to make discrimination and it is absent when subjects must only detect the presence of a stimulus (Mangun & Hillyard, 1991). This finding was supported by a recent research in 2014 that investigated the

role of N100 ERP component in measuring customer's preferences to logos. This study found that visual N100 component is largest over occipital region or the inferior temporal regions (Bokura *et* al., 2001; Hopf *et* al., 2002) and the higher amplitude of this component is related to enhance processing of the attended region of brain (Luck & Hillyard, 1994; Vogel & Luck, 2000). Changes in N100 amplitude of occipital lobe can affect anterior areas widely. As a result, the amplitude of P300 and other late components in central and frontal lobes would definitely be affected by early components and it proved the significant role of pre-comprehension attended regions in prediction of logo's preference (Nazari *et* al., 2014).

P200 is typically elicited as part of the normal response to visual stimuli and has been studied in relation to visual search and attention, language context information, memory and repetition effects. The P200 may be a part of cognitive matching system that compared sensory inputs with stored memory (Freunberger *et* al., 2007). The exact function and neural source of the P200 is not yet known, but some evidence indicated that the P200 may reflect general neural processes that occur when a visual or sensory input is compared with an internal representation or expectation in memory or language context (Evans & Federmeier, 2007). This component has been identified in many different cognitive tasks including selective attention (Johnson, 1989; Hackley *et* al., 1990), stimulus change (Näätänen, 1990), feature detection processes (Luck & Hillyard, 1994) and short-term memory (Golob & Starr, 2000). Topographic distribution of P200 generally found maximal towards the frontal area consistent with findings from previous studies that found topographic distribution of P200 is characterised by the shift at the frontal sites (Heslenfeld *et* al.,

1997; van der Stelt *et* al., 1998). However there have been some topographical differences noted in ERP studies of the P200 in different experimental conditions.

N200 typically is evoked before a motor response, suggesting its link to the cognitive processes of stimulus labelling and distinction. Past research focused on the N200 as a mismatch detector, but it has also been found to reflect executive cognitive control functions and has recently been used in the study of language (Folstein & Van Petten, 2008). N200 is characterised by higher inter-individual variation (Pekkonen *et* al., 1995) and has multiple psychological interpretations including orienting response, stimulus discrimination (Satterfield *et* al., 1990) and target selection (Donchin *et* al., 1978; Key *et* al., 2005).

According to Balconi & Mazza, (2009), N200 is distributed more on the frontal sites for both conscious and unconscious stimulus attention. Several distinct N200 potentials have been characterized which one set reflecting involuntary processing, while another evoked through active processing. In repetitive stimulus-presentation, the N2a is evoked by either conscious attention to or ignoring of a deviating stimulus, distributed toward anterior cortical. The N2b is a negativity of central cortical distribution seen only during conscious stimulus attention. While, the N2c arises frontally and centrally during classification tasks (Pritchard *et* al., 1991; Patel & Azzam, 2005). Furthermore, stimuli presented in visual search tasks with specific laterality and which are task-relevant may evoke an N2pc deflection, as an index of attentional shift in the occipital-temporal region of the contralateral cortex (Luck *et* al., 1997).

P300 reflected cognitive processing and particularly reflected working memory processes (Polich, 2003). P300 amplitude indicated stimulus information where greater attention produces larger P300 wave while P300 shorter latency indicated superior mental performance (Sur & Sinha, 2009). P300a is viewed as indicator of memory updating (Donchin & Coles, 1988), while some viewed it as reflection of combination of processes that vary by task and situation including stimulus discrimination and response preparation (Verleger, 1988). The latency is assumed to reflect the duration of stimulus evaluation (Donchin & Coles, 1988).

The classical P300 component or P3b has a parietal distribution on the scalp and has been linked to the cognitive processes of context updating, context closure, and event-categorization (Donchin & Coles, 1988; Verleger, 1988; Kok, 2001). Topographic distribution of P300 was slightly towards the frontocentral distribution consistent with findings from previous studies that found topographic distribution of earlier P300 is characterised by the shift at the frontocentral distribution (Friedman et al., 2001).

Nonetheless, despite a large number of studies with different neurophysiological and imaging techniques, the identification of the brain regions responsible for the P300 remains controversial. fMRI-based generators yielded a convincing model that explains most of the variance of scalp ERPs during a visual stimulus task. Parietal and inferior temporal areas mainly contributed to the P3b and precentral areas and the insula contributed to the P3a. The differential contribution of frontal and parietal areas resulted from different demand on the attentional

subsystems in target and distractor processing (Bledowski *et* al., 2004). Table 1.2 showed the brain area related to ERP.

Table 1.2: The brain area related to ERP

ERP Component	Brain area
N100	The N100 component is largest over occipital region or the inferior temporal regions (Bokura *et* al., 2001; Hopf *et* al., 2002). Changes in N100 amplitude of occipital lobe can affect anterior areas widely as well (Nazari *et* al., 2014).
P200	The topographic distribution of P200 generally found maximal towards the frontal area (Heslenfeld *et* al., 1997; van der Stelt *et* al., 1998).
N200	The N200 is distributed more on the frontal sites (Balconi & Mazza, 2009). The N2a is distributed toward anterior cortical, the N2b is a negativity of central cortical distribution, the N2c arises frontally and centrally (Pritchard *et* al., 1991; Patel & Azzam, 2005) and the N2pc deflection distributed in the occipital-temporal region of the contralateral cortex (Luck *et* al., 1997).
P300	The classical P300 component or P3b, has a parietal distribution on the scalp (Donchin & Coles, 1988; Verleger, 1988; Kok, 2001), whereas the slightly earlier P3a, which has a frontocentral distribution (Friedman *et* al., 2001).

1.2.2.2 Eye Tracking technique

Eye Tracking is another neurophysiological method used to measure the effect of marketing stimuli. Eye Tracking has emerged as one of the important methods in practical marketing applications such as brand equity, segmentation, new product development, pricing decisions, place decisions, promotion decisions and social marketing studies (dos Santos *et* al., 2015). The main target of the Eye

Tracking method is to assess the allocation of visual attention and visual behaviours. Eye Tracking is defined as a tool that measures the gaze point and pupil dilation (Zurawicki, 2010).

The application of Eye Tracking allowed measurement in fixation (looking at the same place for a while) and pupil size (pupil dilation responses) which were related to the information on the screen and behavioural choices during an experiment. Fixation is the moment when eyes are fixed on an object and it is possible to enjoy it in detail and time lengths of fixations indicate attention, while pupil size is the pupil dilation responses and served as identification for attention and emotion (Nielsen & Pernice, 2009; Wang, 2011). Eye Tracking technology offers the possibility of capturing visual behaviour in real-time and monitoring locations of fixations within images (Hansen & Ji, 2010). Jacob & Karn (2003) theories stated that there is a link between Eye Tracking data and cognitive processes. As long as the person looked at the word or image, he or she is cognitively processing that word or image for exactly the recorded fixation duration. Hence, gaze direction can be linked to the focus of attention (Petersen & Posner, 2012).

Understanding the mechanisms that guide customers to select certain points of interest in an image and forecasting the places of greatest interest have many applications for the business world (Zhao & Koch, 2013). Therefore, even from various different marketing issues, Eye Tracking can provide information on what is more relevant to the involvement of attention as it is related to patterns of visual fixation (Piqueras-Fiszman *et* al., 2013). One of long-standing issues in Neuromarketing is product and what would attract customer's attention. Eye