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Using Electroencephalogram (EEG) to Understand The Effect of Price Perception on Consumer Preference

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Abstract. *The research examines the influence of price as product cues on consumer's perception and evaluation by using the application of electroencephalogram (EEG). This method can give objective information about consumer reactions towards product cues that will drive consumer's choice. The main research objective was to observe and evaluate consumer's brain activity in different brain regions while they were being exposed by several price levels (low, medium, high) of underwear as stimuli and focused mainly on liking/disliking the stimuli. The participants consist of 10 female and 10 male consumers within 18-24 years old, have normal vision, right handed, and considered as potential purchasers of underwear. The participant's brain activity was collected using Emotiv EPOC neuroheadset (EEG) with international 10/20 system and was obtained in Beta frequency bands (13–30 Hz). The result indicated that there was a clear and significant change ($p < 0.05$) in the EEG brain spectral activities of right and left hemisphere in the frontal (F3 & F4), temporal (T7 & T8), and parietal (P7 & P8) regions when participants indicated their attentiveness towards each price level stimulus. The results show, the male and female participant's tactile sensations in parietal lobe does not give more favorable attention towards particular price stimulus, but the difference price perceptions in parietal lobe can lead to rational preference and give most favored response towards high price stimulus. Analyzing of price perception may help to understand the differences in price-related emotions and preference, which can gain insights into an alternative pricing strategy that can lead to influence consumers buying decision.*

Keywords: EEG, price, perception, preference, underwear.

1. Introduction

Price is a key tool and significant determinant of consumers' purchase decisions, also excessively used to attract consumers to a certain product. Different ways of price level have different impacts on consumer's perception and furthermore on their purchase decisions. The fact that consumers react differently towards price stimulus is widely known. identical price stimulus can be evaluated differently by several persons (Diller 2008). The fact that consumers respond differently facing prices is a main focus of behavioral pricing research. Behavioral pricing research can be regarded as an extension of the traditionally economic pricing theory, which is based on the assumption of a rational thinking buyer according to the "Homo economicus". Due to consumers' general limitations of price knowledge and cognitive capacity in order to

compare all offered price information, behavioral pricing research reflects how consumers actually perceive, evaluate, and respond to price information (Estelami and Maxwell 2003; Skouras, Avlonitis, and Indounas. 2005; Müller-Hagedorn and Kierdorf 2007).

Several studies have advocated that price perception is a complex and broad stimulus which consists of positive and negative cues to consumers (Lichtenstein, Ridgway, and Netemeyer, 1993). Many research in the consumer literature has demonstrated that consumers use higher prices as being indicative of greater product quality (Rao and Monroe, 1989). To influence consumers' price perception of a certain product is an important challenge for marketers (Diller 2008). The relationship between price and perceptions is a relatively understudied research field. The few existing studies show

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that attention and emotion play an important role in price-related contexts (O'Neill and Lambert, 2001) and that they can mediate the impact of price perceptions on shopping intentions (Zielke, 2011).

Underwear is everybody basic needs, currently in the apparel marketplace, underwear became one of product category that growing rapidly both in innovative design and technology (Askin, 2004; Capelaci, 2006). Thus in the future this industry still will grow, profitable, and become one of potential product category in the market (Nugrahani, 2013).

Nowadays the market trends are changing and consumers are looking underwear category for both function and fashion. Underwear products that previously considered as inner wear now being designed as leisure wear and meant to be worn as outerwear, many customers look at undergarments as a style statement and has equal emphasis as their outerwear garments (Bailey, 2005). This challenging condition is making it difficult for managers to identify particular pricing strategy that can influence consumer's buying decisions in the increasing undifferentiated underwear market. However many companies are possessing variety of product price strategy to influence consumer's buying decision. This s makes it even more challenging and complicated for consumers to rationally take decisions regarding product quality (Hume & Michael, 2013).

Underwear is common privately consumed product category in apparels. However, previous studies in this context have documented that underwear got inherently deficient in the literature. The recent study have focused on publicly visible, conspicuously consumed products such as fashion apparel and accessories (Phau & Yip, 2008; Kim, Knight, & Pelton, 2009; Jin, Park, & Ryu, 2010) (Kim, Knight, & Pelton, 2009), electronics (Hamzaoui & Merunka, 2006; Hui & Zhou, 2003; Lee & Ganesh, 1999) and automobiles (Hamzaoui & Merunka, 2006). Very little research has been done with

underwear as an object, due to the fact that it was considered as boring and private product category. Taking into account the fact that underwear consumer is part of a largely untapped consumer group whose their buying decisions are relatively still unknown.

The previous research findings, have been stated that consumer information processing in underwear product are involving multisensory integration of information, mostly based on visual and tactile (Fiore, 2000). To making sense of consumers choice towards underwear products, besides conducting survey, it is helpful to understand their actions in conjunction with their neural response mechanisms especially when other senses are involved in the choosing process, such as vision and tactile (Knutson, Rick, Wimmer, Prelec, & Loewenstein, 2007).

To making sense of consumer's price perception in underwear products, it is helpful to understand their actions in conjunction with their brain response mechanisms that happened during active evaluation of products and have been found can predict consumer preference (Kushaba, et al., 2013). While underwear is an intimate apparel that very private for most of people, and it was still believed taboo to become a topic of discussion. Based on that situations, many consumer's might be feel uncomfortable and not reveal "what they feel" and "what is their preference". By using electroencephalogram (EEG) to get the consumer's brain response, will provide strong evidence how is the effect of consumer's perception can affect their preference, also contribute to marketers knowledge of the "why" behind the consumer's buying decisions regarding underwear product, that can help marketers to reach their target markets more effectively and develop strategies to ensure that the consumer's needs are met.

This study portray price perception among consumers with different stimulus of price level. Specifically, by comparing the differences in consumer's brain activity

(EEG) among the price level perceptions. The objective of this study is the effect of price level perceptions towards price preference of underwear product by comparing the differences in consumer's brainwave (EEG). Analyzing of price perception may help to understand the differences in price-related emotions and preference, which can gain insights into an alternative pricing strategy that can lead to influence consumers buying decision.

2. Literature Review

2.1. Price

Price is what is given up or sacrificed to obtain a product in consumer's perspective. Price is used as a quality indicator when other cues available are limited, when the product cannot be evaluated before purchase, and when there is some degree of risk inherent in making wrong choice; a key variable that influences consumers' purchase intention (Idoko, Ireneus, Nkamnebe, & Okoye, 2013). In an experimental setting, Jacoby and Olson (1977) distinguished between objective price (the actual price of a product) and perceived price (the price as encoded by the consumer). The price of a particular product is one of the key tools in understanding consumer choice (Bijmolt, van Heerde, & Pieters, 2005). Researchers have investigated the social role of price in decision-making (Amaldoss & Jain, 2005) and errors made by consumers when processing the price of an item (Bizer & Schindler, 2005).

2.2. Perception

Perception is a mental (cognitive) process that involves using previous knowledge to gather and interpret the stimuli gathered by the senses. Thus perception involves input and recognition of sensory experience (Walters, Bergiel, & Sheth, 1989). Van Der Walt (1991) adds that perception occurs when sensory receptors receive stimuli via the brain, code and categories them and assign certain meanings to them, depending on the person's frame of references that consists of all the previous consumer's experiences, beliefs, likes, dislikes, prejudices, feelings and other psychological reactions of

unknown origin. The perceptions process is also complicated due to the possibility that individuals may be stimulated below their level of conscious awareness. In the perception process, exposure is the first step that occurred. Exposure occurs when a stimulus comes within the range of our sensory receptor nerves. Exposure is therefore simply the minimum requirements of perception. Exposure is very important because no matter how great a message is, it will not be perceived unless a person is exposed to the stimulus (Wells, Turtle, & Luus, 1989).

2.3. Consumer Preference

An important issue in marketing is how consumers form preference for products or services, because preference is one of the factors that give big influence to choice. The term "preferences" can be used in a variety ways, one could interpret the term "preference" to mean evaluative judgment in the sense of liking or disliking an object when a person likes one of the alternatives more than /the other, he has developed preference for the one liked and is more likely to choose it. Preference is also used primarily to mean an option that has the greatest value among a number of options (Blackwell, 2006). This refers to a choice between alternatives and the possibility of rank ordering of these alternatives, based on the degree of happiness, satisfaction, gratification, enjoyment, or utility they provide.

2.4. Electroencephalogram (EEG)

The electroencephalogram (EEG) is a measure of brain waves that provides evidence of how the brain functions over time (Tong & Thakor, 2009). Nowadays, EEG are increasingly used by marketing scholars and practitioner to get consumer's deeper reactions to various marketing stimuli (Ariely, Berns, Moore, & Noussair, 2010). The general assumption is that human brain activity can provide marketers objective information that not obtainable via conventional marketing research methods. This is mainly driven by the fact that people cannot fully explain their preferences when

explicitly asked in the level of conscious awareness. The EEG records are seen as indicator of consumer's true emotions and feeling because there are several activations in certain regions in the brain that may suggest the consumer's unfiltered response (Davidson, 1992). EEG is possible to gather immediate feedback to presented stimuli as fluctuations in brain signal frequencies to learn more about attention, perception, and emotion (Vecchiato, et al., 2011) and also provides a richer context to understand consumer choice and decision making process in marketing research (Ohme, Reykowska, Wiener, & Choromanska, 2009).

3. Methodology

3.1. Participants

The participant for this research were consists of 10 males and 10 females underwear shopper among 18-25-years-old the age of free-spending and impulsive buying, have normal vision, not in the process of psychoactive medication, with neither a history of neurological nor psychiatric disturbances, right handed, and have monthly spending \geq Rp 3.000.000. 3.000.000 indicate they spending power is high and appropriate sample for this research because they have ability to purchase freely (Wood, 1998).

3.2. Procedures

To test brain response of the participants were used Emotiv EPOC Neuroheadset International 10/20 System. It consists of 14 EEG channels + 2 references placed in the right and left hemisphere, and represent five brain part. The EEG channel coded by the electrode position and hemisphere position (Figure 1): F (Frontal Lobes), FC (Fronto-Central Lobes), AF (Antero-Frontal Lobes), P (Parietal Lobes), O (Occipital Lobes), T (Temporal Lobes), CMS (Common Mode Sense), and DRL (Driven Right Leg). In addition, the left hemisphere was coded by odd number and right hemisphere by even number.

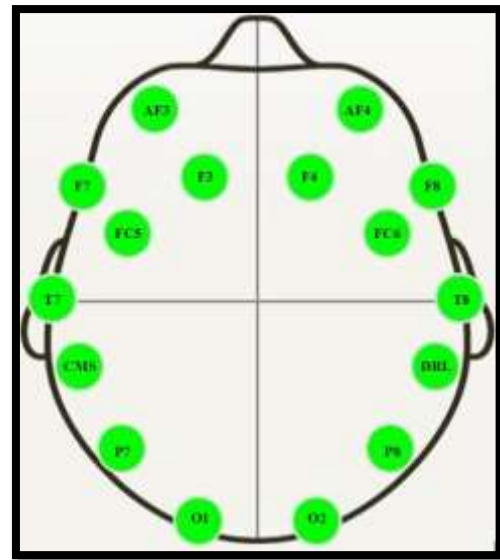


Figure 1. Headset Map of 10/20 system

The participants were asked to evaluate several underwear color and brand elements. Each data was recorded using OpenVIBE 0.13.0 and EPOC Panel Control software and was analyzed by MATLAB R2009a which complemented with EEGLAB. For underwear's price evaluation, a blind test was also used. The participants were told to touch three different underwear, each for 30s with 3s inter-stimulus-interval, and repeated 3 times with the inter block interval (IBI) 10-15 minutes. Each of underwear was told have different price (low price, medium price, and high price). The electrodes were located on F3- F4, T7 -T8 and P7-P8.

EEG data processing begins with selecting the raw data obtained from the EEG data recording. The raw data from Emotiv being translated to be numeric data in the form of csv file. Then the raw data was processed through several stages below:

1. Offset removal, is the noise waveform (waves with 0 frequency) filter (band-pass filter).
2. Artifact removal, is filter for the artifacts waveform due to participant's muscle movement such as eye blinking or head movements. The disposal of artifacts waveform made with the assumption that the amplitude of artifacts is 2.5 times greater than the average brain wave signals. Thus the signals with amplitudes greater than the average brain wave signals will be discarded and replaced by the previously

recorded data signal.

3. Separation of beta wave data from other brain waves with the filtering process using the filter beta waves (13-30 Hz) thus obtained wave data as shown in Figure 3.16. Beta wave data then processed in numerical form. Beta wave power value obtained from the square of the voltage waveform of data recorded by Emotiv.

The increased beta waves in treatment session was measured by comparing it with baseline session result then made it into data pooling to see the trend towards the increased in beta waves in general.

4. Result and Discussion

Data pooling of beta wave spectrum in channel F3 was compared with channel F4 (Frontal Lobe), channel P7 with channel P8 (Occipital Lobe), also channel T7 was compared with channel T8 (Temporal Lobe) to determine EEG asymmetry for the left hemispheres (F3, P7, and T7) and right hemispheres (F4, P8, and T8). Based on the result of underwear price evaluation (Figure 2), when the stimulus was given, generally the beta brainwaves amplitude of male and female participants increase compared with baseline values in each brain lobe (occipital lobe, temporal lobe, and frontal lobe). The results indicate that underwear price stimulus generally can modulate the activity of neurons in parietal, temporal, and frontal area becomes more active. This is caused due to the transient effects of underwear price stimulus in the tactile pathways natural adaptations towards the environmental conditions.

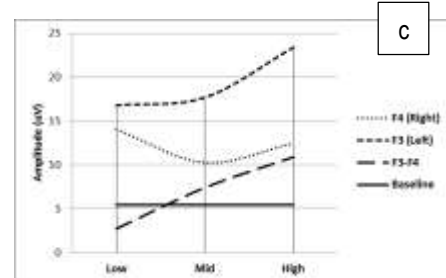
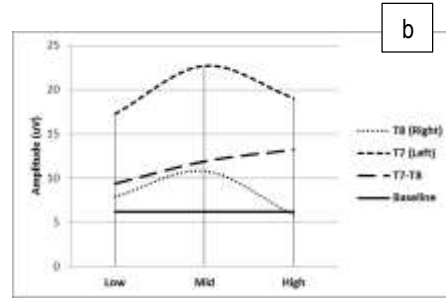
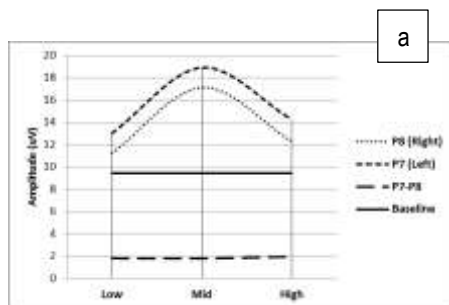


Figure 2. The female Consumer β brain waves mean difference during underwear price stimulus in: (a) parietal channel; (b) temporal channel; and (c) frontal channel

For female participants results (Figure 2), shows that the amplitude value in left hemisphere is higher than right hemisphere, whether in parietal lobe (P7-P8), frontal lobe (F3-F4), and temporal lobe (T7-T8). Based on paired sample t- test in each lobe, there are significant difference between amplitude activity in left and right hemisphere, P7-P8 $t(6.717) = 8.559, p < 0,05$; T7-T8 $t(6.162) = 15.772, p < 0,05$; F3-F4 $t(10.761) = 14.501, p < 0,05$. Based on the results, generally female participants give positive response towards all underwear price stimulus. Furthermore, female participant's data in each brain lobe (P7-P8, T7-T8, and F3-F4) was analysing by using One-Way ANOVA test. The results show there is no real difference between the beta waves amplitude of each underwear price stimulus in parietal lobe P7-P8 $p = 0.65 > 0,05$. This can be happened because they had been given the same sensory tactile information (same fabrics), so they feel quite same tactile sensations. However the price perception in each price stimulus is difference (T7-T8 $p = 0.00 < 0,05$) based on temporal lobe results and high price has the highest amplitude value among all stimulus. This results also found in frontal lobe F3-F4 $p = 0.002 < 0,05$, female participants response differently towards each underwear price stimulus and

high price has the highest amplitude value among all stimulus. We conclude, however the female participant's tactile sensations in parietal lobe does not give more favourable attention towards particular price stimulus, but the difference price perceptions in parietal lobe can lead to rational preference (the frontal lobe) and give favoured response to the high price stimulus.

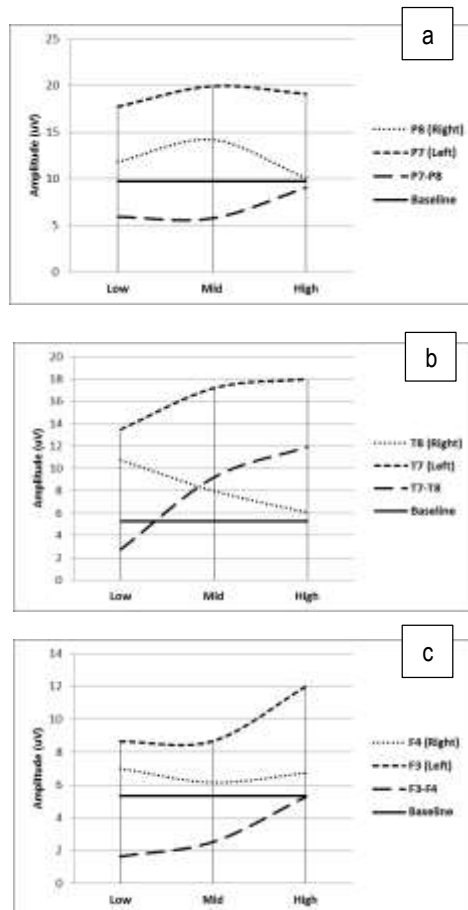


Figure 3. The male Consumer β brain waves mean difference during underwear price stimulus in: (a) parietal channel; (b) temporal channel; and (c) frontal channel

While in male participants results (Figure 3), most of beta brainwaves amplitude value in left hemisphere is higher than right hemisphere, whether in parietal lobe (P7-P8), frontal lobe (F3-F4), and temporal lobe (T7-T8). Based on paired sample t-test in each lobe, P7-P8 $t(12.753) = 7.790$, $p < 0.05$; F3-F4 $t(19.16) = 13.735$, $p < 0.05$; and T7-T8 $t(9.7926) = 11.126$, $p < 0.05$, there are significant difference between amplitude activity in left and right hemisphere. So generally, the male participants give positive response towards all fabrics stimulus that

were given. Furthermore, male participant's data in each brain lobe (P7-P8, T7-T8, and F3-F4) was analysed by using One-Way ANOVA test. The results shows, there is significance difference between beta brainwaves amplitude of male participants in each brain lobe, parietal lobe P7-P8 $p = 0.03 < 0.05$; F3-F4 $p = 0.00 < 0.05$; and T7-T8 $p = 0.01 < 0.05$, that indicate the male participant respond differently towards each underwear price stimulus. Generally the beta brainwaves amplitude value of high price stimulus is the highest among all stimulus (low price and medium price), whether in parietal lobe (P7-P8), temporal lobe (T7-T8), and frontal lobe (F3-F4). The results indicate the difference of consumer price perception (temporal lobe) can lead to different touching sensations (parietal lobe) and different price choice in male participants. Based on the results, male participants give more favourable choice towards high price, same as female participants. In this case, male and female tend to use price as an indicator of product quality. Thus price might be an indicator of perceived quality of underwear (Dapkevicius & Borisas, 2009). This result similar with Lambert (1772), Shapiro (1973), and Olson (1977) that stated price reliance is a general tendency in some consumers to depend on price as a cue to quality. In several studies (Zeithaml, 1988; Kotler *et al.*, 2003; and Bou-Llusar, Camisón-Zornoza, & Escrig-Tena, 2001), overall association between price and perceived quality is high.

5. Conclusions

The result of this study shows the male and female participant's tactile sensations in parietal lobe does not give more favourable attention towards particular price stimulus, but the difference price perceptions in parietal lobe can lead to rational preference and give most favoured response towards high price stimulus. The current study highlights the applications of neuroscience in order to fully explore the decision-making process from the perspective of underwear consumer's that can give objective information about the inner workings of the consumer brains. It will provide the insight

about how underwear consumers perceive the product price and can give information to improve the pricing strategy to be as compatible as possible with consumer.

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