

May 2012

## The Story of Taste: Using EEGs and Self-Reports to Understand Consumer Choice

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### Recommended Citation

Brown, Charnetta; Randolph, Adriane B.; and Burkhalter, Janée N. (2012) "The Story of Taste: Using EEGs and Self-Reports to Understand Consumer Choice," *The Kennesaw Journal of Undergraduate Research*: Vol. 2 : Iss. 1 , Article 5.

DOI: 10.32727/25.2019.5

Available at: <https://digitalcommons.kennesaw.edu/kjur/vol2/iss1/5>

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# The Story of Taste: Using EEGs and Self-Reports to Understand Consumer Choice

## Cover Page Footnote

This research was partially funded by the Kennesaw State University's Coles College of Business Research and Development Committee.

## **The Story of Taste: Using EEGs and Self-Reports to Understand Consumer Choice**

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### **ABSTRACT**

The authors investigate consumers' willingness to switch from a preferred manufacturer brand to an unfamiliar private-label brand if taste is perceived as identical. Consumer decisions are examined through recordings of electrical brain activity in the form of electroencephalograms (EEGs) and self-reported data captured in surveys. Results reveal a willingness of consumers to switch to a less-expensive brand when the quality is perceived to be the same as the more expensive counterpart. Cost saving options for consumers and advertising considerations for managers are discussed.

**Keywords:** neuromarketing, consumer behavior, branding, taste test, EEG

In today's challenging economy, consumers may be more conscious of price when making purchasing decisions but still be unwilling to sacrifice quality (Ariely & Berns, 2010; Bolton, Lemon, & Verhoef, 2008; Dragolea & Cotirlea, 2011; Perrachione & Perrachione, 2008; Plassman, O'Doherty, Shiv, & Rangel, 2008). This inclination extends to the decision to purchase manufacturer brands versus private-label brands. When making sense of consumers' decision-making processes, it is helpful to understand their actions in conjunction with their thoughts especially when other senses are involved in the decision, such as taste. Neuromarketing is a burgeoning field allowing researchers to learn more about the hidden thought processes of consumers by analyzing the structure and function of the brain (Lee, Broderick, & Chamberlain, 2007). In the

present study, neuromarketing tools are utilized to understand consumer responses to a manufacturer soft drink brand in comparison to an unfamiliar private-label brand.

The neuromarketing toolset most commonly includes electroencephalograms (EEGs), functional near-infrared (fNIR), and functional magnetic resonance imaging (fMRI) techniques often recorded from the frontal lobe of the brain to learn more about emotion, judgment, and attention (Davidson, 1992; Fugate, 2007; Vecchiato et al., 2011). Using electrophysiological responses in the form of EEGs, it is possible to gather immediate feedback to presented stimuli as fluctuations in brain signal frequencies. Functional near-infrared and fMRI are both methods that reflect brain activity based on measuring oxygenated blood volume in

different areas of the brain where this oxygenated blood is needed to fuel various thought processes. Functional magnetic resonance imaging uses powerful magnetic forces (three times that of the Earth's pull) to gain deeper and finer resolution in resulting images than with the more shallow penetration of infrared light used with fNIR techniques (Kleinschmidt et al., 1996).

Neuromarketing techniques are increasingly used by marketing scholars and practitioners as they work to gauge consumers' deeper reactions to various stimuli (Ariely & Berns, 2010; Ohme, Reykowska, Wiener, & Choromanska, 2009; Wilson, Gaines, & Hill, 2008). The resulting measures are seen as more indicative of the true emotions and feelings of consumers because activation in certain regions of the brain (i.e., blood flow to the right frontal lobe or left frontal lobe) may suggest the person's unfiltered response (Davidson, 1992). Further, such brain imaging information coupled with surveys and observational data provide a richer context within which researchers may better understand consumer behavior and decision-making (Ohme et al., 2009). In particular, marketing scholars have employed EEGs and fMRI in efforts to understand consumers' responses toward various forms of advertising (Ohme et al., 2009; Morin, 2011; Vecchiato et al., 2011) as well as their taste preferences (McClure et al., 2004; Plassman et al., 2008).

The use of EEGs and fMRI in taste tests is relatively new, as previous research in this area relied upon self-report measures (Kamotani, Hooker, Smith, & Lee 2010; Ottenfeld, Bernstein, & Witte, 2008; Robinson, 2007). Though self-report measures are useful, the combination of these measures and brain imaging technology are lending tremendous additions

to the marketing field (Davidson, 2004; Hazlett & Hazlett, 1999; Ohme et al., 2009). For example, McClure et al. (2004) examined cultural biases of Coke and Pepsi in a blind taste test study utilizing fMRI. In the study, they examined the hippocampus and dorsolateral prefrontal cortex of the brain and subjects' decision-making about products through motor behavior. In the current research, we seek to contribute to the body of knowledge on the use of brain imaging technology by examining the frontal lobe. The frontal lobe was chosen as another area of the brain to study in its relation to decision-making because research conducted by Davidson (1992) indicated that the frontal lobe generates neural activity that reflects emotions and feelings, where the frontal lobe is primarily involved in affect-guided decisions. He analyzed the EEG asymmetry of waves within the alpha spectrum (8-13 Hz) on the left and right hemispheres of the frontal lobe. Upon presenting film clips designed to generate positive and negative emotions, Davidson concluded that larger activations in the left hemisphere were an indication of happiness or amusement and larger activations in the right hemisphere indicated disgust. Therefore the present study will use similar coding to understand if:

Hypothesis 1: Individuals will have a strong preference of either an indication of like (left frontal lobe activation) or dislike (right frontal lobe activation) to a particular brand based on their implicit positive or negative emotional connection to the brand being consumed.

Burshteyn and Buff (2008) investigated the process of stimulus generalization and revealed higher levels of product liking based on participants' familiarity with the product where visual

EEG asymmetry was correlated with self-reported familiarity. Stimulus generalization is defined as the “degree to which a response conditioned to a particular stimulus is also evoked by similar stimuli” (Till & Priluck, 2000, p. 56). In this particular study, stimulus generalization was examined as it relates to branding. Specifically, the researchers were interested in whether the private label brand which is presumed to be similar to a manufacturer label brand, evoked stimulus generalization. One recommendation from this study was to examine a different cortex of the brain to understand its impact on stimulus generalization and EEG asymmetry. By examining the frontal lobe as Davidson (1992) has noted, we are able to understand if participants will elicit a familiar response to the brands. If this response is elicited, will the response reveal a like or dislike to the brands tasted? The recommendation presented by the researchers will be addressed in the current study; specifically stimulus generalization is translated into familiarity in the present study where:

Hypothesis 2: Individuals are more likely to reveal a higher level of liking -- activation in the left hemisphere -- to the manufacturer brand over the unfamiliar private label brand due to product familiarity.

Hypothesis 3: Consumers are willing to consider switching to the private label brand if taste is perceived as identical.

In this study and many like it, brand familiarity and brand loyalty are more ways that brain-imaging technology is used in neuromarketing to understand consumer behavior (Burshteyn & Buff, 2008; Marketing Week, 2005; McClure et al.,

2004; Mucha, 2005). Electroencephalograms have been used to explore reactions to brands presented in television advertisements (Ioannides et al., 2000; Rossiter, Silberstein, Harris, & Nield, 2001; Young, 2002) and consumer choice studies (Amaldoss & Jain, 2005; Bizer & Schindler, 2005; Maynes & Assum, 1982; Plassmann et al., 2008) as they relate to price. The price of a particular product is one of the key tools in understanding consumer decision-making (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). Research on price has also been combined with other variables to understand consumer behavior. For example, Maynes and Assum (1982) report that consumers may pay too much for similar products because there is a price dispersion leaving the market informationally imperfect. Plassmann et al. (2008) investigated whether individuals would rate the experienced pleasantness of wine differently given the price of each beverage in a taste test study. Researchers found that participants rated wines with a higher price as having a more pleasant taste than the cheaper wine. Plassmann et al.'s (2008) research reveals that price has a stronger role in perceived quality when the beverage is held constant. It would be interesting to examine if participants will be willing to switch to a less expensive brand when the quality is perceived to be similar. Thus, the current research seeks to understand whether:

Hypothesis 4: Experienced pleasantness and price will drive individuals' willingness to switch if the stimulus generalization of tasting the beverage is held constant.

Based on the aforementioned neuromarketing taste studies, it appears that consumers are influenced by familiarity and price when making a purchasing decision. Examining taste tests and perception alone, it appears that some consumers are influenced only by taste while others are influenced by price. Thus, the purpose of the present study is to investigate consumers' willingness to switch from a preferred manufacturer brand to an unfamiliar private-label brand if taste is perceived as identical. Different from previous studies, we accomplish this by measuring EEG activity *while* participants taste the two brands individually, make an assessment based on taste alone, and then provide additional feedback after learning about price differences. Measuring EEG activity coupled with the survey assessment of the beverages gives a comparison of participant decision-making to physiological reflections of decision-making including emotion.

## Method

### Participants

Participants were recruited via word-of-mouth on the campus of a large university in the southeastern region of the United States. The 12 volunteers who participated in the research (8 female, 4 male) ranged in age from 21 to 50. Approximately 75% of the participants were employed for pay, and the number of hours worked ranged from 12 to 50 ( $M = 26.43$ ,  $SD = 14.35$ ). When asked to estimate "how financially well-off your household is," 9 of the 12 participants provided a response. Seven of these nine respondents (78%) reported to be as well-off as most families. Of the remaining participants, one reported to be somewhat less well-off than most families and another

reported to be somewhat better off than most families.

### Materials

We chose a well-known manufacturer brand and a less familiar private-label brand of soft drink. We used one private-label brand and one paired manufacturer label brand similar to the procedures in Burshteyn and Buff (2008). Participants were asked to rate their brand loyalty for the manufacturer label brand and then this loyalty was tested through a blind taste test. The blind taste test was followed by the individual's recognition of each beverage and selection of which beverage he or she liked more based on the perceived pleasantness of flavor. This procedure was similar to the taste test in Plassman et al. (2008) with the caveat that the participants were given the price after drinking each beverage and rating its pleasantness. Brand loyalty, taste preference, brand recognition, and price perception were all measured through the explicit means of a survey tool. Taste preference was also measured implicitly using EEG. Both beverages contained similar caffeine content.

Electroencephalography was used to record electrical brain activity, and three Likert scales were utilized for rating brand loyalty and pleasantness. The Likert scales were administered within a larger online survey that included demographics. The Raju, Unnava, and Montgomery (2009) three-question, nine-point Likert scale ranging from 1 (*disagreement*) to 9 (*agreement*) was used to assess brand loyalty. Taste preference was assessed using Plassmann et al.'s (2008) pleasantness 6-point Likert scale ranging from 1 (*do not like it at all/not intense at all*) to 6 (*like it very much/very intense*). Participants were asked, "Which brand would you prefer after

looking at the pictures of each cola tasted?” either “Picture A” or “Picture B” to understand their brand recognition. To understand price perception participants were shown the same two pictures with one option choice and asked, “Given the price, which cola would you consider purchasing?”

Printed photographs of a manufacturer brand and a private-label brand soft drink were prepared for use as visual stimuli during a rating task. Finally, individual canned drinks were used within a taste test portion of the study. The brand of each beverage was covered to maintain anonymity.

## Procedure

During the recruitment phase of the research process, participants were informed that the study would be a taste test involving a soft drink. Participants were also informed that this study would include one in-person session that should last for no more than 1 hour. Consenting participants first completed the brand loyalty survey. After completing this survey, participants were seated and fitted with a standard electrode cap for recording EEGs using an eight-channel bioamplifier system connected to a personal computer (www.cortechsolutions.com). Selected in random order, both the manufacturer and the private-label brand drink were tasted. Each drink was sipped intermittently cued by an arrow appearing on the participant’s monitor over a period of two minutes while recording EEGs. After tasting each beverage, participants cleansed their palette using water as a constant and rated the pleasantness of each. Then a picture of each brand was presented to participants for them to select their preference.

Next, a researcher presented the prices of the two brands to participants and asked them a question about which product they would consider purchasing based on the price and the pleasantness of the beverage. Finally, the EEG sensors were removed and the participants answered demographic questions before concluding the study. At the end, the identities of the beverages were revealed. Participants were asked to select a can of their choice of beverage to take home and were debriefed on the purpose of the study.

## Results

### Emotion

The recorded EEGs were averaged across each two-minute segment to show overall activations for each of the eight electrode channels. In particular, activations were analyzed over the frontal lobe area of the brain, which were recorded by three channels labeled F3, FZ, and F4 according to the standard international 10-20 schema for headmaps. As cited in Davidson (1992), these channels are commonly used to observe emotion. Activity was observed across these channels for both drinks. Based on an activation plot of EEG frequencies across all recorded channels, the highest amplitude value within the alpha spectrum for channels F3, FZ, and F4 was pinpointed and recorded. Channel F3 was compared with channel F4 to determine EEG asymmetry for the left and right hemispheres where F3 is over the left hemisphere and F4 is over the right hemisphere. The activation plot was generated by a MATLAB plug-in according to differentials between rest and active periods. The plots were run and analyzed by a trained technician.

There were no significant differences between private-label and manufacturer

brands on channel F3,  $t(22) = -.379$ ,  $p = .708$ , or channel F4,  $t(22) = 1.385$ ,  $p = .180$ , or a difference between the two channels,  $t(22) = -1.473$ ,  $p = .155$ . Thus, the drinks appeared to be similar in taste, which was in contrast to what was predicted in Hypothesis 1. Both drinks exhibited overall responses within the beta frequency range indicating arousal. Specifically, there were more individuals who had a neutral feeling about the private-label brand ( $n = 8$ ) than the manufacturer label brand ( $n = 4$ ). There were distinct emotional connections of like and dislike between the manufacturer label and the private label. The manufacturer label appeared to have a more distinct emotional connection -- like ( $n = 6$ ) and dislike ( $n = 3$ ) -- than the private-label brand -- like ( $n = 2$ ) and dislike ( $n = 1$ ). This categorization of "like" or "dislike" was based on the calculated EEG asymmetry of the frontal lobe for each beverage tasted. Participants also verbally gave their opinions of each beverage after tasting. From these opinions, it seemed that participants were able to perceive a higher level of carbonation on their pallet when tasting the manufacturer brand as compared to the private-label brand. However, it also seemed that participants could not determine much difference between the two beverages because they wanted to taste the beverages again to see if they could discover any differences; this desire to re-taste lends anecdotal support for Hypothesis 2.

Participants' ratings for the degree of brand loyalty was averaged across the three question, nine-point Likert scale survey with each question's scale range of 1 (*disagreement*) to 9 (*agreement*). The questions were averaged because no one question truly gauged a participant's loyalty to the manufacturer brand. The results of the three-question average ( $M = 5.00$ ,  $SD = 2.04$ ) suggest that participants were neutral

to the manufacturer brand mentioned in the survey.

### Pleasantness & Preference

A  $2 \times 2$  mixed-groups ANOVA was used to analyze which brand participants preferred based on order of presentation (between-subjects variable) and brand of drink (within-subjects variable). This analysis was done in attempt to understand if individuals would change their self-reported brand preference from the manufacturer brand to the private-label brand, regardless of which they tasted first. Results revealed a marginally significant effect of brand, Wilk's  $\lambda = 0.77$ ,  $F(1, 11) = 3.05$ ,  $p = .11$ . Although the statistical significance was marginal, the effect size ( $\eta^2 = .23$ ) indicates the difference is of moderate practical significance.

There was no significant effect of the order of presentation,  $F(1, 11) = 0.189$ ,  $p = .67$ , nor was there an interaction between order and brand, Wilk's  $\lambda = 0.99$ ,  $F(1, 11) = .122$ ,  $p = .73$ . So, participants seemed to prefer the manufacturer brand ( $M = 4.42$ ,  $SD = 1.31$ ) more than the private-label ( $M = 3.58$ ,  $SD = 1.68$ ), regardless of which they tried first.

A paired-sample  $t$ -test was used to understand how participants rated the taste of each beverage. The results for the perceived pleasantness were also in contrast to Hypothesis 1, indicating that participants could not taste a difference between the beverages using the self-report measure used in the Plassmann et al. (2008) study,  $t(11) = -.321$ ,  $p = .754$ . The average ratings given for both beverages were consistent with the neutral emotions felt during the EEG portion of the study.



When price was not an issue, the majority (83%) preferred the manufacturer brand to the private label brand when shown a picture of the product without the price. This preference for the manufacturer brand supports Hypothesis 2, which suggests higher levels of liking for familiar brands. When participants were shown a picture of the products with their respective prices, where the private-label brand was significantly cheaper, 50% of the participants who initially selected the manufacturer brand switched to the private label brand. Also, 100% of the participants who initially chose the private label brand chose the private label brand after price was introduced. McNemar's test revealed this change in preference to be approaching significance,  $p = .063$ . This switching behavior from the manufacturer brand to the private label brand supports Hypotheses 3 and 4.

### **Behavior**

The incentive portion of the study was used to understand if participants' behavior was actually impacted by the study and they were willing to switch brands. Most of the participants (10 out of 12) chose the private-label brand as their incentive. One participant said, "I only shop at the store that the [private-label] brand comes from for a food pantry, and I always thought I should buy my own food from this store. I just never did. But this study has answered some of my questions about the differences between [manufacturer brands] and [private-labels]. So, I will buy more products from this store." Another participant thought about what others would say if she used the product outside of the home but also in the home for leisure and for a party. In the end, the participant still chose the private-label brand, indicating that regardless of how she would consume the beverage that the price

was well worth the switch. Though this portion was not part of the overall study, it lends support for Hypothesis 3. Two participants chose the manufacturer brand as their incentive. Interesting to note, those same two participants also chose the manufacturer brand throughout the study, and distinctly tasted a different level of carbonation in the beverages, thus demonstrating their brand loyalty even when given the price.

## **Discussion**

### **Emotion**

Electroencephalographic analysis revealed that there were more participants who felt a neutral emotion for the beverages than a significant like or dislike as work by Davidson (1992) would suggest. This could be due to the familiar taste of the cola beverages, consistent with past research by Burshteyn and Buff (2008) indicating that participants could not distinguish between the different brands presented in the study. Also, this neutral emotional connection to each brand also helps to understand why participants were more willing to switch to the less expensive brand.

### **Pleasantness & Preference**

Consistent with the general design of a blind taste test (McClure et al., 2004), participants were asked to rate which brand they preferred based on taste and disclosure of the brand alone. The stimulus generalization and product familiarity that was found in Burshteyn and Buff (2008) was also found in our study with over three-quarters of the participants choosing the manufacturer label product when the brands were revealed. The average ratings provided on the survey for each brand during the taste test portion coincided with the neutral

findings on the EEG measure. This consistent finding indicates that the familiar taste of the beverages collected in the survey of pleasantness and EEG measure drove the switching behavior where half of the participants who originally chose the manufacturer brand switched to the private label brand once price was introduced.

### **Behavior**

Behavior in this study was reviewed after the debriefing of the research study when participants were given the option to take either beverage as their incentive. Verbal responses were presented to give another representation of switching behavior. Overall, participants acknowledged that they would switch from the manufacturer brand to the private label brand after the study and these participants chose the private label brand as their incentive. Though this section was not a significant part of the research study, it did provide more information on switching behavior.

### **Conclusion**

Past research suggests (McClure et al., 2004; Plassmann et al., 2008) that participants will rate the quality of a beverage based on the price and familiarity with the brand, choosing that particular brand over the less familiar, less expensive brand. On the contrary, the results of this study indicate that individuals are willing to switch to a less expensive, less familiar brand if the price is less expensive and the taste is perceived to be the same. Although willingness to switch does not necessarily equal a change in actual buying behavior, these results provide key information for marketers. Understanding that participants may be willing to switch from a manufacturer to a private-label brand if both

brands are similar in flavor may provide private-label brand managers with additional ammunition in their advertising campaigns. This is especially important in the current economy when consumers are eager for cost-saving options without sacrificing certain pleasures.

As with most studies, this investigation also possessed some limitations. The small sample size and confinement to a university setting in a southern state may limit the generalizability of the findings. The results of the research presented were approaching significance and we believe that with a larger sample these could be significant. Future researchers should expand the number of participants for increased rigor, especially in reference to emotion and brand preference.

Another limitation of the present study may be that some individuals had a preference for a particular product and these product options were not given. Researchers should include a question about participants' actual familiarity with a particular brand's taste because emotion results indicated that individuals might be more familiar with one over another. Also in our study, we did not ask any follow-up questions about how the beverages tasted but instead recorded verbal reports that the participants provided. If a similar study is conducted in the future, a follow up questionnaire addressing the participants' experience with each beverage should be used to understand specific taste differences. Although the present study included a single tasting of each beverage, future researchers may conduct multiple tastings of the same beverages to corroborate initial findings.

Lastly, individuals may respond differently to caffeine and carbonation, thus affecting EEG recordings to some degree.

To control for the varying effects of caffeine, a non-caffeinated beverage could be included; however, it has been found that caffeine typically increases alertness levels (Hartley, Lovallo, & Whitsett, 2004; Lane & Williams, 2007) and amplifies EEGs (Liu et al., 2004; Guger et al., 2009) indiscriminately across the brain. Finally, tests should include more than one stimulus and include products that participants currently use in order to gauge their willingness to switch.

Overall, this paper illustrates how neuromarketing tools are utilized to better understand consumers' actions in conjunction with their thoughts when other senses, such as taste, are involved in their decisions. Such methods are shown to

reveal more than survey methods alone by uncovering the true thoughts and emotions of participants. Although future research is suggested to further understand consumers' behavior, the research presented expands taste test literature by further highlighting the usefulness and legitimacy of neuroscience techniques as applied to marketing themes.

### Acknowledgement

The authors would like to acknowledge support for work in the Kennesaw State University BrainLab made in part by funding from the Coles College of Business Research and Development Committee.

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