Analyzing Antecedent Factors of Cognitive Dissonance Using E-Commerce Data

Keiko Yamaguchi, GiXo Ltd., JAPAN
Makoto Abe, University of Tokyo, JAPAN

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ABSTRACT
This paper provides managerial guidance on the factors that might prompt cognitive dissonance using actual e-commerce panel data. This is achieved by translating cognitive and emotional antecedent factors found in previous research into observables through online data and constructing a hierarchical model to control individual heterogeneity and situational differences.

INTRODUCTION
Under fierce competition, e-commerce firms need to aim at increasing the average customer spending through cross-selling and up-selling. To increase the revenue per customer, many EC sites encourage their customers to purchase more products and/or more expensive goods through the use of a recommendation system. However, such purchases are often accompanied by cognitive dissonance in the mind of customers (Holloway, 1967). When this happens, consumers try to resolve the dissonance mainly by two means (Festinger, 1957). One way is to search for information that justifies their purchase decision (Rosenfeld et al., 1986), and the other is to return the purchased product. If the cognitive dissonance is not resolved, it can lead to the customer’s dissatisfaction toward the product and the store (Montgomery and Barnes, 1993), generating negative word-of-mouth, or even stop shopping at the store altogether (Hunt, 1991). Therefore, finding a customer’s action that might prompt cognitive dissonance is crucial to help companies to address cross-selling and up-selling effectively.

Current research into cognitive dissonance offer little guidance to identify a consumer’s action forewarning its occurrence. Most studies are conducted through surveys or experiments in laboratories, providing limited applicability to the field setting of EC. When cross-selling and up-selling, EC sites need to know what kinds of shopping behavior and types of product might lead to the consumer’s action forewarning the occurrence of cognitive dissonance, so that sellers can take preventive measures in advance.

In light of these gaps and concerns, we aimed to find the “precursor”, the consumer’s action that might prompt cognitive dissonance, and provide managerial guidance on capturing the presages and taking preventive actions in a novel way. Unlike most consumer behavior studies, we utilized field data, specifically actual access log and purchase data collected by an EC site, in the following manner. First, by observing a post purchase online behavior, we classified customer purchases into two categories: one with the precursor and one without. Second, we translated latent antecedent factors of cognitive dissonance that have been validated in previous studies, such as the customer’s cognition and feelings, into observable shopping behaviors, product attributes, and customer characteristics. We then constructed statistical models to relate these factors to the precursor of cognitive dissonance.

This study contributes to the theoretical and practical knowledge of cognitive dissonance in two ways. First, we confirmed the antecedent factors of cognitive dissonance in a field setting. Previous research has relied mainly on survey studies because many of these factors are unobservable. Furthermore, their theory testing was conducted at the aggregate level by controlling individual differences in a laboratory setting. Such an approach permits the inclusion of few moderating variables that might affect the occurrence of cognitive dissonance. In contrast, we used panel data to analyze each customer at multiple points in time, accounting for not only situational differences but also individual differences in the occurrence of cognitive dissonance. We incorporated an idea proposed by Festinger (1957), that the occurrence and frequency of cognitive dissonance differ among customers and purchase occasions, into our model to confirm their validity. As far as we know, this is the first empirical study to address this heterogeneity issue. Second, we obtained insight into observable antecedent factors from access log data, which allows EC sites to take preventive actions so that customers do not experience cognitive dissonance.

CONCEPTUAL BACKGROUND
Among numerous empirical studies of cognitive dissonance, our research is related to investigation of its antecedent factors. The factors studied in previous research include choice difficulty (e.g., Menasco and Hawkins, 1978); emotional factors, such as anxiety about the act of the purchase itself (e.g., Hunt, 1970; Keng and Liao, 2013); confidence of the rightness of a purchase decision (e.g., Bell, 1967; Keng and Liao, 2013); and cognitive factors, such as needs for product knowledge (e.g., Sweeney et al., 2000). Some research has proposed methods to measure the strength of these antecedent factors in stimulating cognitive dissonance (e.g., Montgomery and Barnes, 1993; Sweeney et al., 2000).

MODEL SPECIFICATION
We constructed a statistical model that relates the precursor of cognitive dissonance to observable antecedent factors. The dependent variable in our model was a binary indicator of whether a post-purchase action-presaging the occurrence of cognitive dissonance is observed or not. The post-purchase action will be explained in detail in the next section. The independent variables were the customer’s shopping behaviors before purchase, attributes of the purchased products, and customer characteristics.

First, we applied a standard binary probit model to establish the relationship. Let $y_{isp}$ denote the post-purchase action at $p$-th purchase in session $s$ by customer $i$. With a latent variable $z_{isp}$,

$$ y_{isp} = I(z_{isp} > 0) $$

where $I(c)$ is an indicator function that returns 1 if condition $c$ is satisfied and 0 otherwise. Given customer shopping behaviors and product attributes $x_{isp}$, $z_{isp}$ is

$$ z_{isp} = x_{isp}' \beta + v_{isp}, \quad v_{isp} \sim N(0, 1) $$

where $x_{isp}$ is a $(K + 1) \times 1$ vector composed of a constant term and $K$ independent variables and $\beta$ is a $(K + 1) \times 1$ parameter vector.

Next, to accommodate that the impact of customer’s shopping behaviors and product attributes on the precursor of cognitive dissonance differs among customers, we relaxes the parameters to be customer-specific as $\beta_i$.

Finally, we tried to identify the factors that cause this customer difference with respect to his/her site usage characteristics. Customer-specific $\beta_i$ is specified by a vector of moderating variables describing his/her site usage, $d_i$, as

$$ \beta_i = Q d_i + n_i, \quad n_i \sim MNV (0, V) $$

where $d_i$ is a $(M + 1) \times 1$ vector composed of a constant and $M$ variables, and $Q$ is a $(K + 1) \times (M + 1)$ parameter matrix (Rossi et al., 2005).
The first model, which assumes that all parameters are the same across customers, is referred to as the “base model.” The second model, in which customer-specific parameters are estimated, is referred to as the “individual model.” The third model, in which customer’s site usage characteristics are hierarchically incorporated into their own parameters, is referred to as the “hierarchical model.” The parameters in these three models were estimated using a Markov Chain Monte Carlo method. The model fits were then compared both in estimation and validation periods.

**Independent Variables**

The independent variables consisted of shopping behaviors, product attributes, and customer characteristics, and were classified into two types. The first type varied from purchase to purchase, and directly affected the occurrence of cognitive dissonance. The second type was stationary (i.e., it did not vary by purchase occasion) and represented customer characteristics of online browsing and shopping behaviors at the EC site. In our study, the direct influence of the first type of independent variable on the precursor of cognitive dissonance was moderated by the second type of variables through hierarchical modeling.

**Direct Variables**

Previous studies found that the higher the purchase price, the more likely and serious the cognitive dissonance becomes (e.g., Kaish, 1967; Oshikawa, 1970; Sweeney et al., 2000). Perception of a purchase price is affected by the internal and external reference prices formed through product search and comparison (Kalyanaraman and Winer, 1995). Hence, we constructed a variable that was a ratio of the price of a purchased product to the average price of the category to which the purchased product belonged, and we named it “RELATIVE PRICE.” The average price of the category was calculated with regular prices in the product catalog provided by the EC portal site. Another price-related variable included was a dichotomous indicator of whether the purchased product was on sale or not, called “SALES.” Several researchers have pointed out that sales promotions stimulate customers to purchase by providing an excuse to rationalize their decision (Beatty and Ferrell, 1998; Hoch and Loewenstein, 1991). This excuse might fade away once the order is placed, and the customer is unable to substantiate the purchase decision afterward. Consequently, we hypothesized that sales prompts the presage of cognitive dissonance.

The more difficult the purchase decision is, the more likely it is that cognitive dissonance occurs after the decision (Holloway, 1967; Montgomery and Barnes, 1993). Multitudes of alternatives spawn the anxiety of whether one made the right decision and fear of regret, thereby causing cognitive dissonance (Bell, 1967; Menasco and Hawkins, 1978; Korgaonkar and Moschis, 1982).

Hence, in this study, we distinguished between purchases with the precursor of cognitive dissonance and normal purchases by observing an online behavior in the gamma phase. The EC portal site we analyzed starts a delivery process on the day of order, and customers cannot cancel their orders once the delivery process begins. Based on this business practice, we defined the gamma period for this online data as the duration from an order till the end of the session. When customers feel cognitive dissonance, they tend to explore information that justifies their decision-making after purchase (e.g., Rosenfeld et al., 1986; Hennig-Thurau and Walsh, 2003). In online shopping, this behavior corresponds to revisiting the product page after placing an order, for example, to view pictures of the product and/or read the product descriptions again. Hence, if a customer came back to the ordered product’s webpage after purchase within the same session, we regarded this post-purchase action as the precursor of cognitive dissonance. The proportion of purchases with and without the post-purchase action was similar for the estimation and validation data, thereby providing validity to this criterion as the precursor to some extent.

**Dependent Variable: Precursor of Cognitive Dissonance**

Sweeney et al. (2000, p.374) stated “The concept of dissonance ... best fits the period that immediately follows the purchase decision but precedes use or experience with the result of the purchase decision.” They conducted a survey of customers who were in a “gamma” phase (Oliver, 1997), that is, in the intervening period between a product purchase and its usage. Likewise, other prior studies that aimed to develop measurements of cognitive dissonance analyzed surveys that were conducted in the gamma phase or immediately following the purchase (e.g., Bell, 1967; Hunt, 1970; Menasco and Hawkins, 1978; Korgaonkar and Moschis, 1982).

We applied our models to actual business transaction data from an anonymous fashion EC portal site in Japan. The data included customer’s access log data and purchase history from September 2011 to April 2013 (JASMAC, 2013). This fashion EC portal site contains over 500 stores on its platform and each store sells one or multiple brands. This category stimulates emotional buying, which is often accompanied by cognitive dissonance (e.g., Clover, 1950; Bellenger et al., 1978; Park et al., 2012). In addition, with numerous variations in color, material, design, style, and brand over a wide price range, choice difficulty may prompt the occurrence of cognitive dissonance (e.g., Menasco and Hawkins, 1978). It appeared that the data from this fashion EC site was ideal for our empirical analysis.

From the database, we selected active customers who had purchased more than 10 times at this EC site during this period and had been a site member for less than 10 years. We further limited the customers to those who had made both types of purchases, with and without the post-purchase action presaging cognitive dissonance, so that customer-specific parameters could be identified. This resulted in 255 customers. The first 90% of the sessions in the data were used for parameter estimation, and the last 10% were used for model validation.

**Figure 1: Estimation Result of the hierarchical model**

* Moderating variables (in italics) are included only if significant at 90% or above credible level

**EMPIRICAL STUDY**

**Data**

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Hawkins, 1978). As a proxy for the difficulty in choice, we used the “NUMBER OF BRANDS” for the category in the EC store where a customer made his/her purchase.

Consumer’s higher self-confidence about the purchase decision makes the occurrence of cognitive dissonance less likely (Bell, 1967; Montgomery and Barnes, 1993). We posited that the longer the elapsed time of a customer’s product search and comparison in the shopping process, the lower the customer’s self-confidence becomes, and thus the occurrence of cognitive dissonance is more likely. Here, we included two independent variables. One was “BROWSING TIME” that represented how long a customer browsed a product during the session in which the purchase occurred. Another was the “NUMBER OF SESSIONS,” which was a logarithm of the number of sessions in which a customer had viewed the same product before the purchase session. We expected that both browsing time and number of sessions would be positively related to the precursor of cognitive dissonance.

Park et al. (2012) showed that sensory attributes, such as the color, textile, and design of apparel products, trigger emotional buying, which tends to cause cognitive dissonance afterward. We focused on product color as a sensory attribute (Rowley 2001) in our study, and created a binary variable, “TREND COLOR,” representing whether the color of the purchased product is a trend color of the year or not. In order to define trend color, we referred to the “Color of the Year” presented by Pantone LLC and set it to 1 if the color of the purchased product corresponded to the color of the year and 0 otherwise. We expected trend color to prompt the precursor.

Ozok and Wei (2010) found that, people prefer using PC over mobile devices in online shopping, because PC’s larger physical interfaces make information retrieval and entry easier. Hence, mobile devices are used more for accomplishing specific purchase tasks, whereas PC is used more for casual browsing, which could lead to emotional purchases with cognitive dissonance. Furthermore, the fact that mobile devices are relatively unsuitable for longtime browsing means their users are less likely to exhibit returned visits after purchase. We constructed “MOBILE” variable, using 1 if accessing via a mobile device and 0 if accessing via PC. We expected mobile to exhibit a negative sign.

Columns 2 to 4 of the table summarize our hypotheses and interpretations about the expected signs of the parameters for the seven independent variables.

**Moderating Variables**

We now describe the independent variables that indirectly affect the presage of cognitive dissonance. These moderating variables depict customer’s site usage characteristics and do not vary from purchase to purchase. The variable “MATURITY” was used to represent the number of days since a customer registered as a member of the site. The variable “MOBILE” was used to represent the number of days since a customer registered as a member of the site. The variable “MOBILE” was used to represent the number of days since a customer registered as a member of the site.

### Table 1

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ If a purchased product is on sale, an excuse to rationalize the purchase tends to prompt the precursor of cognitive dissonance.</td>
<td>Kaish (1967), Oshikawa (1970), Montgomery and Barnes (1993), Sweeney et al. (2000)</td>
</tr>
<tr>
<td>+ If a relative price of a purchased product is expensive, its higher stake tends to prompt the precursor of cognitive dissonance.</td>
<td>Hoch and Loewenstein (1991), Beatty and Ferrell (1998)</td>
</tr>
<tr>
<td>+ A purchase induced by sensory attributes tends to tend to prompt the precursor of cognitive dissonance.</td>
<td>Park et al. (2012), Rowley (2001)</td>
</tr>
<tr>
<td>+ For a purchase with longer browsing time, a consumer has lower self-confidence, and the precursor of cognitive dissonance is prompted.</td>
<td>Bell (1967), Kaish (1967), Montgomery and Barnes (1991)</td>
</tr>
<tr>
<td>+ If a consumer browse a product many times in sessions prior to the purchase, a consumer has lower self-confidence, and the precursor of cognitive dissonance is prompted.</td>
<td>Ozok and Wei (2010)</td>
</tr>
<tr>
<td>+ Purchase decision more difficult with more brands, thereby prompting the precursor of cognitive dissonance.</td>
<td>Bell (1967), Holloway (1967), Menasco and Hawkins (1978), Montgomery and Barnes (1991)</td>
</tr>
</tbody>
</table>

**In Sample Fit**

- **Marginal Loglikelihood**: 6163.35 4555.56 4545.69
- **DIC**: 6170.00 4697.49 4719.10

**Holdout Sample Fit**

- **-2 Loglikelihood**: 613.52 596.72 603.55

** Significant in 95% credible interval
* Significant in 90% credible interval
of the EC portal site as of the last day in the data. The variable “SINTERVAL” was used to represent the average store-visit interval for the EC site. The variable “CVARIATION” was a ratio of the number of colors that a customer purchased divided by the total number of purchased products. If the colors of the purchased products were all different, CVARIATION equaled 1.

Next, two variables were related to customer’s online shopping behaviors. Arnold and Reynolds (2003) studied hedonic browsing, which is a type of browsing that seeks entertainment, pleasure, and recreational values. They tried to link six motivations to hedonic browsing. We adapted two of the six motivations, which were value shopping and idea shopping, from the access log data. Value shopping is a shopping behavior for the purpose of bargain-hunting. In this EC site, most brands usually conduct a sales promotion in January and July every year. We regarded the two-month periods centering on January and July as sale periods and calculated “CHERRY PICKER” to indicate the fraction of visits during the sales over the entire period. We regarded CHERRY PICKER as a proxy for value shopping tendency.

Idea shopping, on the other hand, is a shopping behavior based on consumer’s desire to be familiar with the latest fashion. In this EC site, new products are launched in early March, June, September, and December. We considered the one-month periods centering on these four time points as new product launch periods. We calculated “TRENDY,” which indicated the fraction of visits during a new product launch over the entire period. Hence, we regarded TRENDY as a proxy for a customer’s idea shopping tendency.

RESULTS

Column 5 of the table shows the estimated parameters in the base model. All estimates had the same signs as hypothesized. The precursor of cognitive dissonance was prompted if the product was on sale, was the trend color, and was expensive. Furthermore, if the browsing time of a product was long (i.e., high browsing time) or a customer browsed the same product many times before purchase (i.e., number of sessions is large), these shopping behaviors tended to cause the presage. The estimate for mobile was negative as expected. The estimate for number of brands was positive, potentially suggesting a positive relationship between choice difficulty and the presage of cognitive dissonance. However, because it was not significant in the 95% credible interval, we excluded number of brands from the subsequent models.

Bottom two rows of the table show the goodness of fit for the three models in this study. First, all indices of the goodness of fit for the individual model were superior to the ones for the base model in both estimation and validation periods. This result indicates that the impact of independent variables on the precursor of cognitive dissonance widely differs among customers, suggesting the importance of accounting for customer heterogeneity. Next, the goodness of fit for the individual and hierarchical models was close to each other in both the estimation and validation periods, which implies that variations in parameters \( \beta_i \) across users are explained well by the site usage characteristics included in the hierarchical model.

We next interpreted the estimates of the individual and hierarchical models in detail. Column 6 shows the basic statistics of the distributions of parameters \( \beta_i \) for each user in the individual model. The signs of the means of \( \beta_i \) were the same as the signs in the base model. The standard deviations differed by variable, suggesting a difference in the extent of the heterogeneity. In particular, the impact of sales, trend color, and mobile on the precursor of cognitive dissonance varied widely by customer. The distributions of relative price, browsing time, and number of sessions had relatively small variations (i.e., standard deviations), implying moderate homogeneity among customers.

The hierarchical model explains the heterogeneity of the parameters by customer’s site usage characteristics. Column 8 reports the estimate of matrix Q, mitigating effect of the moderating variables on the direct impact of product attributes and customer’s shopping behaviors.

First, we looked into the relationship between the intercept (i.e., base tendency to prompt the precursor of cognitive dissonance) and the site usage characteristics. Customers who visited this EC site during a sale (CHERRY PICKER), who were likely to choose various colors (high CVARIATION), and who frequently visited this EC site (small SINTERVAL) were likely to presage the cognitive dissonance. In other words, sales promotions and sensory attributes, such as color, were likely to prompt the precursor of cognitive dissonance. The presage was not likely to arise for infrequent visitors because they tended to have specific purposes in mind to buy something and less emotional buying may occur.

Next, we examined the moderating variables (MATUREY and TRENDY), both of which were significant at over a 90% credible level on some variables. Customers may not presage cognitive dissonance if they are more experienced with the EC site (Olson and Dove, 1979; Tse et al., 1990). If customers are relative novices, their insufficient knowledge and uncertain expectations about the store might lead to less self-confidence about the purchase, which subsequently can prompt the precursor after the purchase. Column 7 shows that the MATURITY variable had a negative moderating impact on all direct factors, implying that the more mature customers become, the less the impact of their shopping behaviors and product attributes become. The sole exception was TREND COLOR, but the result was not significant. In particular, the moderating effects of MATURITY on sale purchases (SALES) and multiple viewing of the product prior to purchase (NUMBER OF SESSIONS) were significant at the 90% credible level.

A similar interpretation applies to the TRENDY variable. Customers who visited this EC site frequently during a new product launch period were knowledgeable and experienced so that the direct effects could be moderated. Column 7 shows that TRENDY also had a negative moderating impact on all of the direct factors that cause a customer to presage the occurrence of cognitive dissonance. Specifically, the moderating effects of TRENDY on sale purchases (SALES) and trend color purchases (TREND COLOR) were significant at the 90% credible level.

CONCLUSIONS

This paper aimed to identify the precursor of cognitive dissonance, confirm its relationship with antecedent factors found in the previous studies, and provide managerial guidance on the observable factors that prompt it. Previous studies indicated that the occurrence of cognitive dissonance differed among customers and purchase occasions. However, they have not yet proven it. In order to substantiate the validity, we utilized longitudinal data of customer’s purchases at multiple points in time to address customer heterogeneity in the individual model, and incorporated moderating variables in the hierarchical model. In addition to this novelty, we offered some managerial implications that were actionable by EC sites by translating the cognitive and emotional factors used in previous studies into shopping behaviors, product attributes, and customer characteristics, all of which are observable through online data.

The results confirmed many of the findings of previous studies. The precursor of cognitive dissonance is more likely to be prompted (1) if purchase decisions are more difficult to make, (2) for prod-
ucts with higher price, (3) for products that are on sale, and (4) for emotional purchases that are associated with sensory attributes. The impact of the last two factors, as well as the use of mobile devices, on the presage of cognitive dissonance varies widely by customer. This heterogeneity is partly explained by how much experience customers have with the EC site. In particular, the effect of shopping behaviors and product attributes that prompt the precursor of cognitive dissonance can be moderated for experienced customers.

There is a limitation in this research. Customers, under cognitive dissonance, might seek information outside of the EC site to justify their decisions. Thus, one potential extension is to consider customers’ behavior on other websites as well as in the offline environment, for example, by combining survey data.

REFERENCES