How Neuroscience Can Inform Consumer Research

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Abstract—Recently, a rapidly growing approach within consumer research has developed under the label of “consumer neuroscience.” Its goal is to use insights and methods from neuroscience to enhance the understanding of consumer behavior. In this paper, we aim to provide an overview of questions of interest to consumer researchers, to present initial research findings, and to outline potential implications for consumer research. In order to do so, we first discuss the term “consumer neuroscience” and give a brief description of recently discussed issues in consumer research. We then provide a review and short description of initial empirical evidence from past studies in consumer neuroscience. Next, we present an example of how consumer research or, more specifically, customer loyalty research, may benefit from the consumer neuroscience approach. The paper concludes with a discussion of potential implications and suggestions for future research in the nascent field of consumer neuroscience.

Index Terms—Consumer neuroscience, consumer research, neuroeconomics.

I. INTRODUCTION

OVER the past few years, consumer researchers have been discussing the use of neuroscientific methods and insights for consumer research and behavioral decision-making. In particular, researchers have addressed issues related to branding, advertising, and consumer decision-making (Ambler and Byrne [1], Deppe et al. [2], [3], McClure et al. [4], Paulus and Frank [5], Zaltman [6], Babiloni et al. [7]). The key motivation for these issues is that, to date, it has not been possible to directly observe the underlying mental processes when subjects perceive marketing stimuli such as advertisements, or when they make purchasing decisions. Despite the pervasiveness and long history of consumer research, little is known about the neural representation of how marketing stimuli affects consumers’ perceptions, their decision-making processes, and their consumption experiences.

In the past, consumer researchers had to rely on varying the stimuli (e.g., prices or packaging) and context factors (e.g., putting subjects in a good or bad mood) in order to measure participants’ reactions (e.g., choice behavior or brand preference). Researchers were thus forced to develop hypothetical constructs that mediate decision-making processes. Some marketing researchers suggest that the neural underpinnings of those constructs will soon be observable directly in vivo because of considerable progress in using neuroscientific tools to observe brain activity (Ambler et al. [8] and [9], Shiv and Fedorikhin [10], Shiv et al. [11]). Taking into account that the first results from the emerging discipline of consumer neuroscience have received considerable attention as expressed by several scientific conferences (e.g., Association for Consumer Research preconferences and special sessions, conference on Neuro Economics (ConNEcs), Neuro Psych Economics Conference) and special issues in different journals (e.g., Journal of Consumer Behavior, Brain Research Bulletin, and International Journal of Advertising) the goal of this paper is to provide an overview of the status quo in the field. With consideration for the audience of this journal, the next section provides an overview of the questions of interest from consumer researchers. We then discuss some initial findings from recent studies, and conclude by giving specific examples that illustrate how consumer neuroscience could enhance the understanding of consumer behavior.

II. PRIMER CONSUMER RESEARCH

Broadly speaking, consumer research investigates how people make consumption decisions, what their objects of consumption are, when they decide to purchase and to consume, and why they purchase and consume [12]. The research integrates elements from psychology, sociology, anthropology, economics, and marketing, and more recently also from neuroscience. The goal is to understand consumer decision-making processes, both from individuals and from groups (e.g., families). Understanding consumer behavior is relevant for management, because it enables decision makers from different institutions (i.e., managers in companies, public policy makers, etc.) to effect informed decisions and to develop strategies that maximize both consumer welfare and well being, and the institution’s profitability.

For example, consumer research studies the ways in which characteristics of individual consumers such as socio-demographics (e.g., age, gender, and income) or personality variables (e.g., risk attitude or reward sensitivity) influence behavioral variables (e.g., attitudes toward specific objects such as brands, toward purchasing decisions, and toward impulsive/addictive behavior). Consumer research investigates motivational processes (e.g., formulation and influence of needs), perceptual processes (e.g., consumer attention and information search), and higher cognitive processes (e.g., attitude and expectation formation toward different available brands) in a prepurchasing stage, as well as information integration during actual purchasing decision and consumer learning (e.g., comparison of expectations with actual consumptions experiences, or loyalty formation) in a postpurchasing stage.
Methodological approaches in consumer research include survey methods and observation of how experimental manipulations influence consumers’ attitudes and behavior. In other words, consumer researchers rely on stimulus-organism-response models from psychology that are based on more or less realistic assumptions about the “black-box” of underlying brain processes. This methodological constraint in consumer research can be seen as the initial starting point of “consumer neuroscience.” Consumer neuroscience attempts to broaden methodological approaches in consumer research by introducing physiological measures and by theorizing based on insights from neuroscience. The idea of introducing physiological measures as another independent variable is not entirely new to consumer research; as early as thirty years ago researchers such as Kroeber–Riel [13] investigated responses of the peripheral nervous system (e.g., skin conductance responses) or eye movements in order to investigate the neural processing of marketing stimuli. However, recent technological advances in measuring neural activity in the brain through functional brain imaging techniques allow real-time observation of the underlying brain processes during prepurchasing, purchasing, and postpurchasing stages of the consumer decision-making process in a laboratory environment. Researchers within the consumer neuroscience community promote the view that findings and methods from neuroscience complement and illuminate existing knowledge in consumer research in order to better understand consumer behavior (e.g., Ambler et al. [8], Klucharev et al. [14]).

III. FIRST EMPIRICAL FINDINGS OF CONSUMER NEUROSCIENCE

Due to the very large number of more general neuroimaging and neuroeconomic studies to date, it is not possible to provide a detailed overview of all studies that could be of interest for consumer research. In the following, we will therefore narrow down to those studies that explicitly focus on questions in consumer research.

Table I is an essential subjective summary of studies which address, more or less explicitly, marketing-related issues such as branding, advertising, or buying behavior. With respect to the primary goal of consumer neuroscience, which is to enhance the understanding of consumer behavior, the studies noted above provide initial insights into the neural underpinnings of advertising processing, choice behavior, and brand preference processing. Although these findings are preliminary, they demonstrate that the underlying brain mechanisms of consumer behavior are very complex. In fact, depending upon the stimuli, the context, and the physiological state of the subject, the brain uses different decision processes that recruit activity in areas distributed over the entire brain. To date, the contributions to consumer research could be summarized as follows.

A. Research on Brand-Induced Preference Formation

The influence of brand associations and brand preferences on decision making and the consumption experience are one of the major topics in consumer neuroscience. The first studies indicated that there is no such thing as a specific “brand area” in the brain that should be addressed by brand management.

Other brand research studies, namely those of Deppe et al. [2], Deppe et al. [3], McClure et al. [4], and Plassmann et al. [17], provide evidence that affective processes are fundamental to successful branding, although the studies do not explain how to “emotionalize” a brand. The findings of Deppe et al. [2]
may be surprising to brand researchers, particularly the conclusion that there is a nonlinear effect of brand equity with respect to how prior brand preference modulates brain activity ("first-choice-brand-effect," see Deppe et al. [2]). To date, this nonlinear effect is still not fully understood and more research is needed on this. However, in a recent lesion-study conducted by Koenigs and Tranel [20], patients with damage in the ventromedial prefrontal cortex (VMPFC) did not demonstrate the normal brand-related preference bias when exposed to brand information during choice as compared to a control population. Moreover, Yoon et al. [16] reported neural differences when subjects made person judgments, as opposed to brand judgments. This could indicate that, on a neural basis, brand personality may differ from the personality of people, which could be of interest for empirical brand research promoting the view that brands have “personalities.” The findings of Yoon et al. [16] might explain why, in some cases, people can hardly describe a brand in personality-related terms such as “friendly” or “exciting.”

B. Research on Advertising

Advertising research studies have often pointed out the important role of emotions for ad memorization (see Ambler et al. [8], Delgado et al. [23], and Klucharev et al. [14]). In advertising research, the hemisphere theory has been widely used (e.g., Rossiter et al. [24]), suggesting that emotion and ratio are represented in different hemispheres of the brain. Research on the neural representation of stimuli-induced emotions, however, could show that emotions are not only processed in the left brain hemisphere, but are also processed bilaterally (e.g., in the left and right hemispheres of such cortical structures as the ventromedial prefrontal cortex, and such subcortical structures as the striatum). However, taking into account the “chequered” or multifaceted character of emotions, it is hard to localize them in the brain (Ochsner and Gross [25]). To the best of our knowledge, emotions seem to be associated with several highly complex brain patterns, and the neural representation of specific emotions such as sadness—as compared to anger—is poorly understood (Ochsner and Gross [25]).

C. Research on Choice Behavior and Purchasing Decisions

Using a term often promoted by the popular press, there is nothing resembling a simple “buy button” in the brain. Instead, the brain recruits different brain processes during choice tasks. Some of these processes involve subcortical brain structures such as the striatum (e.g., Plassmann et al. [17]). Most studies report that structures in the prefrontal cortex attempt to control the impact of emotions as expressed, for instance, in impulse buying. Reducing (enforcing) these areas of executive control can have an impact on what and how people buy (Ambler et al. [9], Ochsner and Gross [25], Paulus and Frank [5], and Riederinkhof et al. [26]). For instance, music might reduce cognitive control, suggesting the reason why music is reported to have a positive influence on unplanned purchasing decisions (Shiv and Fedorikhin [10]).

IV. EXAMPLE: CAN CONSUMER NEUROSCIENCE BE APPLIED IN ORDER TO BETTER UNDERSTAND CUSTOMER LOYALTY?

We have provided a brief overview of first findings of consumer neuroscience, and below we illustrate the approach of consumer neuroscience by using customer loyalty as an example. Customer loyalty can be defined as “a deeply held commitment to rebuy or repatronize a preferred product/service consistently in the future” (Oliver [27]). We have selected customer loyalty as an example for the following reasons.

First, research in customer loyalty has attracted increased attention from marketing researchers (e.g., Bell et al. [28]) and findings are published in top tier marketing journals (e.g., Dick and Basu [29]).

Second, while early research tried to establish whether customer loyalty has impact on aspects of business performance (such as profit margin and sales), researchers are still attempting to explain the theoretical foundations of customer loyalty (Johnson et al. [30]).

Third, loyalty is a psychological construct that develops over time during a learning process of the consumer. Learning theories have received considerable attention in neuroscience and more recently also in the nascent field of neuroeconomics (e.g., Caplin and Dean [31]). Thus, loyalty research can benefit from insights in neuroscience and neuroeconomics about how learning processes are represented in the brain.

Fourth, customer satisfaction and commitment play a central role in loyalty research. Most of the studies have looked merely at cognitive aspects of these constructs, however some studies found that affective processes have a higher impact on satisfaction and loyalty (Westbrook and Oliver [32], Evanschitzky et al. 2006 [33]). To better understand the role of affective processes for customer loyalty, neuroimaging might complement existing methods in this area because it enables an online measure of unconscious and conscious aspects of affect-based loyalty during the time of decision-making.

In the following section, we attempt to show that consumer neuroscience can enhance the understanding of customer loyalty. In doing so, we apply the Temporal-Difference-Learning-Model (TDLM) (Schultz et al. [34]). This model has primarily been used for solving the reinforcement learning problem. While we assume that building customer loyalty is comparable with the more general process of learning, we suggest that the application of the TDLM, in particular the TD learning algorithm, might be useful to explain the development of customer loyalty from a neuroscientific perspective. The basis for this suggestion can be found in a recent study by Plassmann et al. [17]. They provide first evidence that a change in neural activity (i.e., in the striatum) correlates with customer loyalty (see Fig. 1). In order to identify these brain regions, they employed Deppe et al.’s first-choice-brand-task [2]. By comparing and contrasting the brain activities of loyal customers with those of disloyal ones, they found significant activity changes in the striatum (marked in yellow and red in Fig. 1, for details of the study, see Plassmann et al. [17]).

The most significant activity changes are reported for the dorsal striatum, a small structure of the brain that is part of the human action-related reward system (O’Doherty et al. [35]).
Against this background, consumer neuroscience research might question how the brain learns to be loyal. The starting point for answering this question could be the general assumption that people behave in a somatic-state-oriented manner. They try to avoid punishments and to receive rewards. Given that the human capability for solving problems is restricted, it is essential that people are able to learn, and to continuously improve their behavior, so that they adapt to the specific environment. This concept could also be applied to explain how people learn to be loyal. In such a condition, the brain would have to manage at least the following three processes in order to learn to be loyal.

1) The brain should be able to memorize and retrieve positive and negative outcomes of former decisions (such as positive experiences after choosing brand A over brand B).

2) The brain should be able to predict several outcomes of choosing between alternatives (buying A or B).

3) The brain needs to integrate the information from processes 1 and 2 into the decision process.

In the following section, we try to explain which brain areas might be associated with each of the above processes. In turn this will illuminate which brain areas might be crucial for developing loyalty and commitment. We assume that if there are deficits in one of these brain areas, for any reason, people will have impairments in developing customer loyalty. Finally, we show that loyalty is the result of a learning process that could be described in terms of consumer neuroscience.

A. Ad 1) Neural Representation of Reward and Punishment

A growing number of studies in neuroscience focus on how the brain processes rewards and punishments (Platt and Glimcher [36], O’Doherty [37], Schultz et al. [34], and Sugrue et al. [38]). Essentially, these studies find that learning from reward and punishment is the result of an interplay of cognitive and affective elements. Orbitofrontal and ventral parts of the medial prefrontal cortex, the amygdala, and the striatum were found to play a key role in this interaction (Canli et al. [39], Morris et al. [40], O’Doherty et al. [41] and [42]). The involvement of these brain areas was reported in studies on the neural responses to sensory stimuli and the receipt of money (Aharon et al. [43], Blood et al. [44], Elliot et al. [45], O’Doherty et al. [41], [42]). Thus, either monetary incentives such as immediate discounts at the point of sale, or a friendly salesperson, might exert a positive impact on customer loyalty. In addition, we know that reactivity in the striatum is prone to individual differences (e.g., because of age, disorders such as depression). To date, such individual differences have not been investigated in consumer research. Also, the interplay of punishment and customer loyalty has not been yet addressed in extenso in loyalty research.

B. Ad 2) Neural Representation of Reward Prediction

The ability to predict rewards or punishments associated with choosing between alternatives (e.g., brand A or brand B) is fundamental for learning. Several neuroscientific studies provide evidence that the amygdala and the striatum are crucial for predicting the physiological outcomes of certain decisions (Gotfried et al. [46], Knutson et al. [47]). A central question recently discussed in neuroscience is how the human brain learns to make such predictions (Bayer und Glimcher [48], Delgado et al. [49], and Schultz et al. [34]). Based on findings in the areas of artificial intelligence (Sutton and Barto [50]) and theoretical-mathematical neuroscience (Dayan and Abbott [51]), the “Temporal-Difference-Learning” algorithm was developed to answer the question of how the brain learns to make predications (Sutton and Barto [51], Schultz et al. [34]). This model includes several variables. At the core of the model is the expected reward \( \hat{V}(t) \). At a certain time \( t \), the expected reward is the sum of a certain weight factor \( w_i \) multiplied by vector \( x_i(t) \) as follows:

\[
\hat{V}(t) = \sum w_i \cdot x_i(t),
\]

For customer loyalty research, the expected reward associated with choosing brand A as opposed to B should be crucial. In fact, this corresponds to findings in marketing research that a fit of expectations and experience is essential for building loyalty and satisfaction (Oliver [52] and [53]; Homburg et al. [54]). In the Temporal-Difference-Learning algorithm, the latter is expressed in \( \hat{V}(t) \), while the vector \( x_i(t) \) represents a construct for modeling the absence or presence of the stimuli in question. Therefore, \( x_i(t) \) can be either 0 or 1 (\( x_i = 1 \) when the stimuli is present, \( x_i = 0 \) when it is not). The value of \( w_i \) is based on the minimum square mean differences between the expected and the experienced reward. It therefore reflects the variance of outcomes perceived by the customer. In order to learn, \( w_i \) is modified at the end of each decision process, that means that customer expectations are not fixed but can vary over time according to the experiences of the customer.

Another related variable that plays an important role is the prediction error (“PE”) or \( \delta(t) \). This variable reflects the degree to which the experienced reward corresponds to the consumer’s expectations, and is defined as follows:

\[
\delta(t) = r(t) + \gamma \hat{V}(t+1) - \hat{V}(t),
\]
In (2), the term \( r \) represents the experienced reward at a certain point in time \( t \). If \( \delta(t) \) is equal or greater 0, meaning that the experienced reward is equal or greater than expected, this should lead to satisfaction which in turn positively influences loyalty. Accordingly, if \( \delta(t) < 0 \), the experiences were lower than expected which, in terms of loyalty theory, leads to disappointment and dissatisfaction.

In addition, (2) also incorporates another variable that has been largely neglected in loyalty research: \( \gamma \), the temporal delay between the expected and the actual reward. Several studies investigating the intertemporal choice indicate that there is a relationship between the value of a reward at the point in time when it is predicted and the time when it is received. Generally, people have the tendency to prefer immediate rewards over delayed ones (Read et al. [55], McClure et al. [56]). For example, McClure et al. [56] found evidence that an immediate reward experience recruits brain areas different from those of a delayed reward experience.

Finally, the temporal-difference learning model defines the delta of the weighting factor \( w_i \) as follows:

\[
\Delta w_i = \alpha \sum x(t) \cdot \delta(t).
\]  

In (3), \( \alpha \) reflects the individual learning rate of the customer. To the best of our knowledge, this variable has not yet been discussed in the loyalty research. However, the learning ability of customers may play an important role in building loyalty.

C. Ad 3) Integration of Predicted and Experienced Rewards in Decision-Making Processes

In order to make advantageous decisions, it is essential that the brain is able to predict which decisions are advantageous and which are not. Recent neuroscientific studies have reported that for such predictions and their integration in the decision-making process, the ventromedial prefrontal cortex and the striatum are crucial (O’Doherty et al. [35]). Related to that finding, several studies could show that activity changes in the ventromedial prefrontal cortex predict whether or not a particular brand is an individual’s first choice (Deppe et al. [2], Koenigs and Tranel [20]).

Considering that all brain structures mentioned above are associated with the entire process of the TDLR, it can be concluded that dopaminergic neurons in areas such as the ventral tegmentum, in particular the nucleus accumbens, generate a signal which reflects \( b(t) \) (Schultz et al. [34]). Recently, fMRI-studies (Delgado et al. [49], O’Doherty et al. [57], McClure et al. [56]) have revealed that, as well as the striatum, the orbitofrontal cortex, the amygdala, and the medial prefrontal cortex are crucial for successful learning. With respect to the findings of Plassmann et al. [17] that indicate that activity similar to the above-mentioned brain structures predict whether or not a customer is loyal, it seems possible to use the TDLR to explain how customer loyalty arises. One benefit of its application to consumer research is that the TDLR yields to a neuroscientific-based explanation of why it is difficult to develop loyalty in some cases, while in others it is not. The degree of difficulty could depend on individual differences with respect to the variables in the above-mentioned model.

V. HOW NEUROSCIENCE CAN LEARN FROM CONSUMER RESEARCH

In the previous sections we have shed light on how consumer research can benefit from neuroscience. In this section, we address the perspective of how neuroscience can benefit from knowledge in consumer research and behavioral decision-making theory. Though it might be premature to delineate these benefits completely, in the overall it is appropriate to speculate that the combination of consumer research and neuroscience might allow researchers to better understand consumer decision making and to learn more about how healthy brains function in everyday decision making. In turn, this may help to identify specific consumption-related dysfunctions. For instance, issues of persons suffering from addictions, or from obesity or compulsive spending, are discussed in both consumer research and in clinical research, but little is known about the underlying decision-making mechanisms of persons with these conditions. While recent evidence indicates that overeating is affected by biases in decision making (Chandon and Wansink [58] and [59]), insights into consumer decision making might, perhaps, increase the understanding of the reasons people are obese and the knowledge of interventions that might decrease obesity behavior. For instance, Christakis and Fowler [60] describe how weight gain occurs in social clusters, and they stress a view that people are influenced by the appearance and behaviors of others. In consumer research, this mechanism is referred to as “anchoring,” meaning that judgments are based not on absolute values but on comparison with implicit reference points. One can speculate that people who are susceptible to anchoring may have a higher risk for obesity. However, little is known to date about the neural mechanisms of anchoring and how to influence it, although such understandings could be quite useful for health marketing (e.g., Jones [61]). In addition, little is known about how insights from neuroscience might support the development of specific rehabilitation methods for recovering higher cognitive abilities (e.g., after a stroke). As mentioned, the 2007 study by Koenigs and Tranel [20] provides evidence that people suffering from lesions in the ventromedial prefrontal cortex are unable to integrate brand-induced emotions into decision making. Taken together with other studies by Bechara and Damasio [62] it can be concluded that this brain area is important for advantageous decision making. Moreover, consumer neuroscience may shed more light on the neural mechanisms associated with specific kinds of addiction like gambling or shopping (Reuter et al. [63], Glimcher et al. [64], Bijou et al. [65]). Therefore, insights from consumer neuroscience may help to identify early stages of those dysfunctions and contribute to the development of better treatments. A better understanding of the human brain, on the other hand, might enable marketing companies to sell unnecessary products to consumers (e.g., cigarettes or alcohol). This “dark side” of consumer neuroscience, often addressed by the popular press, needs to be discussed very carefully by researchers in consumer neuroscience. Moreover, consumer neuroscientists should take care about the ways in which their findings are presented by the popular press and are used for
commercial purposes (e.g., by marketing consultants). Particularly, they must be cautious about the tendency on the part of the press and marketers to oversimplify the research results, which has the potential to create fear or disappointment. To date, transferring the scientific results gained from the restricted contexts of consumer neuroscience to real life applications is still in a preliminary stage.

VI. CONCLUSION

In this paper, we have presented an overview of the nascent field of consumer neuroscience. We began by outlining questions of interest to consumer research. Then an overview of first studies in the field of consumer neuroscience followed, leading to an example of how knowledge in neuroscience can be employed to advance theorizing in consumer behavior, i.e., customer loyalty. To extend our proposal, we changed perspective and introduced ideas about how neuroscience may learn from knowledge in consumer research. To conclude, it must be admitted that research in the field of consumer neuroscience is still in its infancy. However, we believe that consumer neuroscience has significant potential to advance both research in neuroscience and consumer research. For this reason, we call for more transdisciplinary work that combines ideas, methods, and existing findings in both fields.

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