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The first decade of consumer neuroscience research has produced groundbreaking work in identifying the basic neural processes underlying human judgment and decision making, with the majority of such studies published in neuroscience journals and influencing models of brain function. Yet for the field of consumer neuroscience to thrive in the next decade, the current emphasis on basic science research must be extended into marketing theory and practice. The authors suggest five concrete ways that neuroscientific methods can be fruitfully applied to marketing. They then outline three fundamental challenges facing consumer neuroscientists and offer potential solutions for addressing them. The authors conclude by describing how consumer neuroscience can become an important complement to research and practice in marketing.

Keywords: consumer neuroscience, reverse inference, replication, brain–behavior relationships

Consumer Neuroscience: Applications, Challenges, and Possible Solutions

Consumer neuroscience research, which applies tools and theories from neuroscience to better understand decision making and related processes, has generated excitement in marketing and cognate disciplines (Ariely and Berns 2010; Camerer, Loewenstein, and Prelec 2004; Plassmann, Ramsøy, and Milosavljevic 2012; Plassmann et al. 2010; Venkatraman et al. 2012). Practitioners' interest in this area has also been increasing. Most of the largest marketing research companies and advertising agencies currently have neuromarketing divisions (e.g., Nielsen, Ipsos, Millward Brown), and the number of specialized neuromarketing research companies is growing steadily (Plassmann, Ramsøy, and Milosavljevic 2012), with clients that represent an impressive list of brands across a variety of product categories (e.g., Google, Campbell's, Estée Lauder, Fox News).

The growth in applications of neuroscience methods to marketing practice stands in contrast to the relatively low visibility of neuroscience in leading marketing journals. Nearly all related research has been published in journals within neuroscience—often in very high-impact journals—suggesting the willing acceptance of such work within the community of neuroscientists (Levallois et al. 2012). In contrast, relatively few articles have appeared in premier marketing journals or high-impact journals in related disciplines such as economics or finance, even though the first examples of such work appeared more than a decade ago (Rossiter and Silberstein 2001). Does this imply that consumer neuroscience advances neuroscience but not marketing research?

Our answer to this question is emphatically no. We believe that consumer neuroscience research can make important contributions to consumer behavior and marketing. Over the past decade, scholars have contributed to consumer neuroscience by conducting foundational work that identifies the basic neural processes underlying human judgment and decision making (for details, see Glimcher and Fehr 2013). Several recent review papers have con-

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cluded that substantial progress has been made in consumer neuroscience, although most of this progress has been to uncover the brain mechanisms underlying information processing linked to decision making (Plassmann, Ramsøy, and Milosavljevic 2012; Plassmann et al. 2010; Smidts et al. 2014; Yoon et al. 2012). Whereas understanding brain functions is of primary interest in the neurosciences, it lies outside the traditional scope of marketing. We assert that this prior work nonetheless lays the necessary groundwork for consumer neuroscience research going forward.

This article is organized as follows. First, we outline concrete ways for consumer neuroscience research to have a more direct impact on marketing theory and practice. Second, we consider several challenges facing consumer neuroscientists and offer suggestions for addressing them. We conclude with an outlook for the future of consumer neuroscience.

APPLICATIONS TO MARKETING

Although a solid foundation for consumer neuroscience research has been laid over the past decade, further advances will depend on the extent to which basic neuroscience research can be translated into clear applications for marketing theory and practice (Levallois et al. 2012). At the same time, it is unrealistic to expect that neuroscience will ever replace the traditional methods used in marketing—a misconception that is sometimes advanced by those eager to overhype the efficacy and promise of neuroscience methods. Instead, we contend that neuroscientific methods provide additional tools and theories that complement more traditional research techniques in marketing and consumer behavior. It is thus important that researchers pay heed to when and when *not* to apply neuroscientific tools. In this section, we focus on five concrete ways in which neuroscientific tools can be applied to improve understanding of marketing theories and consumer behavior.

These five points are based on the notion that brain imaging allows for the measurement of neural activity not only during actual marketing-relevant behavior (e.g., attention, memory, affect, choice) but also in the periods directly preceding and following such behaviors. In these periods, important information processes are taking place that are crucial to better understanding consumer behavior. In other words, neuroimaging can help behavioral researchers turn the “black box of the consumer’s mind into an aquarium” (Smidts 2005, p. 3).

Point #1: Identifying Mechanisms

Neuroimaging tools can help validate, refine, or extend existing marketing theories by providing insights into the underlying mechanism. One such example involves the study of self-control failures. A popular model for explaining self-control is the strength model, which posits that the exertion of self-control relies on some kind of resource in the brain. Because this resource is actively expended by acts of self-control, less of it is available for subsequent acts of self-control (Baumeister, Vohs, and Tice 2007). Glucose has been proposed as the resource in question, with differences in brain glucose levels under resource depletion purportedly serving as the biological foundation of the strength model of self-control (Gailliot et al. 2007). However, the role of blood glucose in self-control has been heavily debated in recent years (Inzlicht, Schmeichel, and Macrae 2014; Job et al. 2013; Kurzban et al. 2013; Lange and Eggert 2014; Magen et al. 2014).

Critically, such a claim is a physiological one, not simply a psychological one. Thus, data and knowledge about the way the brain functions can be critical for establishing the validity of such claims. In this particular context, measurements of brain metabolism indicate that the brain does not store glucose in significant quantities, as posited by depletion models, but instead uses multiple redundant mechanisms to ensure a continual supply of glucose through the vascular system (Peters et al. 2004). It is very unlikely that any form of brain functioning, including self-control, could be depleted and replenished by a short-term intake of glucose (Job et al. 2013). Therefore, any such effects observed in prior studies should reflect an indirect, psychological effect and not a physiological one. A recent study highlights the critical role of beliefs about willpower in mediating this indirect effect between glucose and self-control performance (Job et al. 2013). Taken together, for the strength model of self-control, knowledge about how the brain processes glucose adds to the understanding that the mechanisms underlying self-control cannot be based on glucose depletion in the brain.

Point #2: Measuring Implicit Processes

Neuroscience techniques can provide information about implicit processes that are typically difficult to access using other approaches. Imagine that you are interested in a decision maker’s responses with moral consequences that are likely to be subject to self-deception and social desirability biases (Prelec 2013). In such cases, neuroimaging tools can be a valuable complement to more traditional implicit measures such as reaction times. Another set of examples includes situations and contexts in which the decision maker is unaware of or unable to articulate why he or she exhibits a specific behavior. For example, people at a dinner party may find themselves drinking a cheap wine and an expensive wine. Most of them may express a preference for the expensive wine, if asked—but does this preference arise because of the physical properties of the wine or because they rationalize that the expensive wine must be tastier? Plassmann et al. (2008) investigated this question by scanning participants’ brains while they consumed identical wines with different price tags and find that higher prices enhanced the actual taste experience as it is encoded in the brain.

Point #3: Dissociating Between Psychological Processes

Neuroimaging can demonstrate dissociations between psychological processes. For example, functional magnetic resonance imaging (fMRI) and related tools can discriminate whether two different kinds of decisions recruit similar or different neural processes and thus whether they are likely to involve similar or different psychological processes. For example, a current debate in the information processing literature is that of the dual-systems framework: an emotional system (System 1) pushes people toward quick, intuitive, and suboptimal choices, whereas a rational system (System 2) pushes people toward more deliberative and compensatory decisions (Evans 2003; Kahneman 2003; Petty and Cacioppo 1986; Sloman 1996). However, in a recent neuroimaging study, heuristic simplifying choices were associated with activation of higher-order, cognitive brain systems, while deliberative choices (consistent with expected utility and cumulative prospect theory models) were associated with activation in lower-order, emotional brain systems (Venkatraman, Payne, et al. 2009). These results suggest that the standard dual-systems framework may be an oversimplification and, often, misleading. Importantly, in this example, the ability to directly measure information processing provides crucial additional data about the underlying processes that could not be obtained otherwise. Other recent examples include debates about whether brands are processed similarly to people (Yoon et al. 2006) and whether hypothetical and real choices have similar neural and psychological consequences (Kang et al. 2011).

Point #4: Understanding Individual Differences

Neuroimaging and other neuroscientific methods can be leveraged to better understand individual differences and thereby elucidate the sources of heterogeneity in consumer behavior (Venkatraman et al. 2012). For example, neuroimaging has been used to identify individual differences in responsiveness to pain placebo effects—a topic of relevance also to understanding marketing action–induced expectancies (Shiv, Carmon, and Ariely 2005a, b). Scott et al. (2007) find that reward-related activation in the nucleus accumbens (NAcc) during a monetary decision-making task predicted how responsive participants were to placebo effects at the behavioral and neural levels. Their findings suggest that the anticipation of clinical benefit, an essential component of placebo analgesia, could be a special case of reward anticipation. An open question for research in marketing is whether these effects of reward responsiveness also explain individual differences in how customers respond to marketing-based placebo effects (Plassmann and Wager 2014).

Scale validation is yet another way in which neuroscience-based insights about individual differences can be fruitfully applied to marketing. This approach is illustrated in a study investigating individual differences in neural activity in regions associated with "theory of mind" abilities across salespeople (Dietvorst et al. 2009). Using fMRI data combined with results from surveys and other traditional methodologies, the authors develop a new scale for assessing salespeople's interpersonal mentalizing skills.

Point #5: Improving Predictions of Behavior

Incorporating neural measures into decision-making models can improve predictions of marketing-relevant behavior. This idea was first tested by Knutson et al. (2007), who show that predecisional activation in relevant brain regions predicted subsequent choice. Other researchers have since applied neuroscience methods to predict population-level real-market data for music albums' commercial success from the neural responses of an independent group of participants to the songs (Berns and Moore 2012) as well as call volume to smoking cessation hotlines from the neural activity of participants who viewed different campaigns promoting the hotlines (Falk, Berkman, and Lieberman 2012). Strikingly, in both of these studies, the neural measures were better predictors of population-level data than self-report measures. The ability of these neuroscience approaches to predict choices in real-world contexts has tremendous implications for marketers.

In conclusion, a vital next step for consumer neuroscience is the integration and aggregation of previous work applying a multimethod approach for establishing meaningful multilevel brain–behavior relationships (Glimcher 2010; Kable 2011; Kable and Glimcher 2009; Yarkoni et al. 2010). Although its value may not be immediately obvious to many marketing scholars, such an integrative approach can serve to deepen understanding of a variety of consumer-related processes. A similar development has already successfully occurred in other areas of psychological sciences (i.e., integration of perception, language, and memory).

THREE CHALLENGES AND SOLUTIONS

To deliver on the points outlined previously, it is imperative that consumer neuroscientists address several obstacles. From a review of the current literature and discussions with academic colleagues, we identify three major challenges facing the field. First, consumer neuroscience studies often face the criticism that they provide correlational evidence but not causal evidence. The second challenge involves the fact that the interpretation of findings often rest on making an assumption about the function of a brain region on the basis of prior studies. In other words, researchers infer, on the basis of previous activations in a particular brain region, that participants must have engaged a specific psychological process (i.e., a reverse inference). The third and last challenge involves the generalizability and reliability issues of neuroscience research, in light of a more general discussion about research standards in behavioral research (Simmons, Nelson, and Simonsohn 2011). We discuss each of these points using examples from a single common method (fMRI), but our points generalize to other methods in neuroscience.

Challenge #1: Consumer Neuroscience Research Informs the Understanding of Consumers' Brains, Not Consumer Behavior

Most cognitive neuroscientists aim to understand how brain function maps onto observed behavior or psychological constructs. Not surprisingly, economists and behavioral researchers argue that understanding brain function, though interesting for neuroscientists, is irrelevant for informing behavior (Gul and Pesendorfer 2008; Harrison 2008).

To address this challenge, it is useful first to understand the different types of relationships that can exist between brain and behavior. The most common kind of inference observed in neuroscience studies, particularly those using fMRI, is based on the correlational relationship between activation in a brain region and a certain behavior or experience—and makes no assumptions about the underlying causal relationship. For example, if the ventromedial prefrontal cortex (vmPFC) and the dorsolateral prefrontal cortex (dlPFC) are activated when participants report their willingness to pay (WTP) for products, we can argue that there is an association between those brain regions and WTP calculations (Plassmann, O'Doherty, and Rangel 2007).

The strongest kind of inference is based on causality. Causality inferences can take two forms. The first form is necessity: if a particular brain region is required for behavior, the behavior cannot occur without activation in the corresponding brain region. For causality claims about necessity, researchers must demonstrate that suppressing activation in the corresponding brain region either completely (in patients with lesions) or temporarily (using methods such as transcranial magnetic stimulation [TMS]) directly affects the ability to exhibit the related behavior (Kable 2011). For example, suppressing activity in the dlPFC through TMS altered decision-making behavior by lowering participants' WTP, consistent with the finding that the brain region is critical for calculating WTP (Bechara, Tranel, and Damasio 2000; Camus et al. 2009).

The second form of causality is premised on the ability to increase the incidence/strength of behavior following an increase in activation in the corresponding brain region. In other words, if activation in a particular brain region is increased temporarily (using methods such as transcranial direct-current stimulation [TDCS]), the ability to exhibit the corresponding behavior should be increased (Kable 2011). In our previous example, if the vmPFC and dlPFC are indeed critical for calculating WTP, then applying TDCS to increase activity in these brain regions should increase participants' WTP estimates. Techniques such as TMS and TDCS are now widely available, noninvasive, and increasingly administered to volunteer participants in academic research (Fecteau et al. 2007; Hecht, Walsh, and Lavidor 2010).

As is evident from this discussion, different kinds of causal inferences can be obtained through the use of various neuroscientific methods. The most commonly used techniques, such as fMRI, do rely on association-based inferences. Although critics have questioned the relevance of such inferences, we contend that they still have important implications for marketing theories. Findings from association-based tests can be very useful for guiding new hypotheses, which can then be tested in future (behavioral) experiments. For example, Karmarkar, Shiv, and Knutson (2015) examine the effect of price primacy by varying whether the price of the product was shown before or after the product was presented. Using fMRI, they find increased activation in the mPFC when price was shown after the product, but not when it was shown before the product. In other words, viewing prices first promoted evaluations dependent on products' monetary worth, whereas viewing products first resulted in evaluations dependent on products' attractiveness. Although these insights are based on associations between brain activations and behavior, they lead to very specific and novel hypotheses about preference for utilitarian versus hedonic items that would have been difficult to obtain from behavioral data alone. Specifically, because price primacy leads to evaluations based on products' monetary worth, it should lead to an increased preference for utilitarian items defined primarily by their functionality and usefulness. A follow-up behavioral study confirmed these "neurally inspired" predictions (Karmarkar, Shiv, and Knutson 2015).

In summary, researchers in marketing should view consumer neuroscience not as an approach that could replace traditional measurements of behavior but rather as a complement that could improve the process of obtaining and interpreting behavioral measures. As with any experimental research, reliable conclusions about process or constructs often result from convergence across multiple experiments (Garner, Hake, and Eriksen 1956). Such a multimethodological approach would combine behavioral manipulations with biometrics such as skin conductance, eye tracking, or fMRI with the goal of leveraging the strengths of each method. Ideally, such multimethodological approaches would be applied such that findings from studies using one method (e.g., fMRI) inform the development of hypotheses and design of a second study using a different method (e.g., traditional behavioral experiments).

Challenge #2: Consumer Neuroscience Relies Primarily on Backward Inference to Identify Psychological Mechanisms

A second challenge involves the extent to which psychological processes can be inferred from neural data. As discussed previously, most of the early consumer neuroscience studies applied a "forward inference" approach by manipulating a psychological process of interest—for example, exposing participants to pictures showing painful situations versus control pictures to study the feeling of pain. The idea of such a forward-inference approach is that the psychological process is known (i.e., seeing pictures of others experiencing pain triggers one's own feelings of pain), but the brain regions associated with that process are unknown; thus, the goal of the experiment is to identify or characterize the properties of those brain regions.

However, a practice that has become common in consumer neuroscience and commercial neuromarketing studies is to use "reverse inference," whereby the engagement of a particular mental process is inferred from the activation of a particular brain region (Poldrack 2006, 2011a). Such studies reverse the reasoning about brain structure-to-function inferences as follows:

- In a current study, when task A was presented (e.g., imagine using an iPhone vs. a Blackberry), brain area Z (e.g., the anterior insula) was active.
- In prior studies, when cognitive process X (e.g., the feeling of love) was engaged, brain area Z (e.g., the anterior insula) was active.
- Thus, the activity in area Z (e.g., the anterior insula) in the current study demonstrates engagement of cognitive process X (e.g., the feeling of love) by task A (e.g., imagine using an iPhone vs. a Blackberry).

This kind of inference is reversed because it reasons backward from the presence of brain activation to the engagement of a particular mental process (Poldrack 2006, 2011a). We assert that the deductive validity of such inferences is limited, and reverse inferences need to be used with caution.

Reverse inference is problematic because concepts studied by psychologists, marketing scientists, and others interested in behavior do not necessarily map directly onto specific brain regions. For example, a study that examines emotional reactions to familiar versus unfamiliar brands may be described in terms of psychological concepts—memory, familiarity, emotional engagement—that are meaningful to behavioral scientists but are not isomorphic with brain computations. Whether a reverse inference is justified thus depends on how well some brain activity matches the psychological concepts used by researchers. Meta-analyses across thousands of neuroimaging studies (Yarkoni et al. 2011) provide statistical measures of the validity of reverse inferences; correspondence can be exceedingly strong for some relationships (e.g., activation in the striatum and anticipated reward processing) but much weaker for others (e.g., activation in the lateral prefrontal cortex and emotion). Failure to recognize the statistical properties of reverse inference can lead to high-profile but erroneous conclusions, such as a study drawing the inference that iPhone usage elicits feelings of love on the basis of activation in the anterior insula (Lindstrom 2011; Poldrack 2011b).

The issue becomes most problematic when the central findings and contributions of an article rest on reverse inference. Several prior articles in the consumer neuroscience literature use reverse inference as a central feature to discuss their findings (for a recent review, see Plassmann, Ramsøy, and Milosavljevic 2012). Thus, an important question is what measures consumer neuroscientists can implement to address the problem of reverse inference in neuroimaging studies. We suggest two solutions, as detailed in the following paragraphs.

The first and most straightforward solution is to implement a theory-driven experimental design that directly manipulates the predicted underlying psychological process. For example, if the research question is to explore whether brand personalities are perceived more as people or as objects, this requires some control or so-called "localizer" task that investigates the neural basis of person perception that can then be compared with neural signatures of person and brand processing, as Yoon et al. (2006) do.

The second solution applies when a study is more exploratory in nature. Some consumer neuroscience studies are intended to explore neuropsychological processes underlying consumer research questions and thus must rely to a greater degree on reverse inference to inform more theory-driven follow-up behavioral or neuroscientific studies. Crucial for such follow-up studies is finding a statistical measure of the reverse inference to be tested—that is, the degree to which the region of interest is consistently *and* selectively activated by the psychological process of interest (Ariely and Berns 2010; Poldrack 2006, 2010). If, on the one hand, a region is activated by a large number of different psychological processes, then activation in that region provides relatively weak evidence of the engagement of the psychological process. If, on the other hand, the region is activated relatively selectively by the specific psychological process of interest, then one can infer with much greater confidence that the process is engaged given activation in the region.

Recent efforts to accelerate progress in cognitive neuroscience have involved greater formal synthesis of the rapidly increasing primary literature (Yarkoni et al. 2010). Several tools and techniques for aggregating neuroimaging data are currently available. Such tools mostly combine meta-analysis and Bayesian statistics to synthesize maps of brain structure to brain function (Poldrack 2011a; for an overview, see Yarkoni et al. 2010, 2011) and provide several statistical measures for reverse inference. One example of such a tool for large-scale automated synthesis is NeuroSynth from Yarkoni et al. (2010), which seems very suitable for addressing the reverse-inference problems consumer neuroscientists face (for methodological details, see www.neurosynth.org and Yarkoni et al. 2011; for a consumer neuroscience application example, see Plassmann and Weber 2015).

In summary, reverse inference is problematic for any research linking neuroscience to behavior—including consumer neuroscience research—but its problems can be addressed by using a theory-driven approach for designing studies and by applying meta-analytic statistical tools to improve interpretations of results. We are optimistic that although meta-analytic approaches are still in their infancy, they will continue to improve the ability of consumer neuroscientists to make meaningful and quantifiable reverse inferences.

Challenge #3: Neuroimaging Studies Are Less Reliable and Generalizable Than Traditional Marketing Studies

Another challenge to neuroscience findings is the perceived lack of reliability due to the considerably smaller sample sizes than those used in traditional psychological research studies. If we consider behavioral research articles published in journals such as *Journal of Consumer Research* and *Journal of Marketing Research*, they typically feature several studies, each consisting of approximately 25–30 participants in each condition across several between-participant conditions, providing converging evidence toward a specific hypothesis while ruling out alternative explanations (Garner, Hake, and Eriksen 1956). A majority of neuroscience research, however, includes a single neuroimaging study with samples of 20–30 participants, largely due to considerations involving high cost and the complexity of conducting the study. The use of small samples raises some important concerns: the reliability of the neuroscience findings, the generalizability of the findings from neuroscience experiments to the population, and increased possibility of opportunistic findings. We address these concerns next.

First, the number of participants is not necessarily small if we consider that most neuroscience studies involve within-subject designs. Although the majority of behavioral studies published in leading marketing journals involve larger numbers of participants, they also frequently involve complex 2 × 3 or 2 × 2 × 2 experimental designs in which the participants are randomly assigned to one of six or eight groups, respectively, with approximately 25–30 participants per cell. Because within-subject designs are used to study the same questions (to the extent possible) in neuroimaging studies, we assert that the sample sizes across fMRI and behavioral studies are, in fact, comparable.

It is important to note that neuroscience data involve repeated designs and are often aggregated across multiple repetitions of the stimuli to increase the signal-to-noise ratio of fMRI data (Huettel and McCarthy 2001). Another critical limitation, therefore, lies with not being able to use fMRI when questions cannot be repeatedly presented. However, unlike the one-shot designs commonly used in consumer behavior studies, the repeated measures designs used in fMRI are much more powerful statistically for detecting differences between conditions.

In addition, it is becoming increasingly common to replicate findings from fMRI studies using follow-up studies.

For example, Venkatraman, Payne, et al. (2009) find activation in the dmPFC relating to individual differences in strategic variability in a risky choice task. In a follow-up study, the authors find activation in a very similar region of the dmPFC relating to individual differences in strategic variability in a market investment task (Venkatraman, Rosati, et al. 2009). Though one could criticize the small samples in each study when considered individually, the replication of findings across different paradigms using independent samples greatly enhances the reliability of the findings.

As in the marketing literature, replications do not always need to involve repeating identical experiments. Instead, findings can be replicated by examining data across multiple similar fMRI experiments in different contexts (i.e., “conceptual” replications). For example, the vmPFC has been shown to play a role in WTP calculations for a variety of items such as food (Plassmann, O’Doherty, and Rangel 2007), trinkets (Chib et al. 2009), social causes (Hare et al. 2010), and money (Chib et al. 2009) across different studies, providing converging evidence for the role of vmPFC in the calculation of value and WTP. Such conceptual replications could be done across different methods. For example, one could make very specific behavioral predictions on the basis of neural activations that then could also be tested in behavioral follow-up studies in the lab or field (Karmarkar, Shiv, and Knutson 2015; Mazar et al. 2014; Plassmann and Weber 2015).

A second concern with small samples is how well the findings generalize beyond the sample and, critically for marketers, how well the findings predict real-world behavior in a larger population. In general, there is a need for more representative samples in experimental studies; this extends even to consumer behavior studies, which also tend to suffer from nonrepresentative (e.g., college-aged, educated) samples. The aforementioned Berns and Moore (2012) study provides an excellent example of neuroscience findings that generalize to a larger group of people. The authors measured brain responses in a small group of adolescents while they listened to songs by unknown artists. They found activation in the ventral striatum to be correlated with self-reported liking scores for the songs across the participants in their study. Strikingly, activation in the same region also predicted subsequent sales of albums over a three-year period. These results provide compelling evidence that neural responses to goods not only are predictive of purchase decisions for those individuals actually scanned but also generalize to the population at large.

The third and perhaps the most serious concern with the use of small samples is the increased possibility of opportunistic findings (false positives), which has recently led to discussions in the behavioral sciences more generally (Simmons, Nelson, and Simonsohn 2011, 2013). Specifically, the use of small samples is likely to bias the results observed. We assert that data aggregation across investigators and multiple studies is an effective way to enhance sample size and power and address the issue of false positives. Accordingly, there is a vital need for more quantitative meta-analyses that attempt to synthesize the results of the many hundreds of published neuroimaging studies as well as much larger primary studies that use sample sizes comparable to those used in behavioral studies of personality (Clithero and Rangel 2013; Yarkoni et al. 2010). Recently, Bartra, McGuire, and Kable (2013) analyzed 206 studies that report activations for higher-valued items compared with lower-valued items at all stages of the decision-making process (decision, outcome anticipation, and outcome receipt). Two regions, the vmPFC and ventral striatum, consistently exhibit greater activity for more valuable items. This pattern reliably occurred across a wide range of decision paradigms, reward modalities, and stages of processing (Bartra, McGuire, and Kable 2013). Furthermore, the patterns of activation in these regions were distinguishable from those in regions consistent with a response to arousal or salience (e.g., medial caudate, anterior insula). Such meta-analyses provide an important check against opportunistic findings resulting from small samples in neuroimaging studies.

CONCLUSIONS AND FUTURE DIRECTIONS

Over the past decade, the field of consumer neuroscience has made meaningful progress in generating insights related to marketing and consumer behavior. We have discussed the ways in which consumer neuroscience can be productively applied to answer important questions, and we assert that the field is now well poised to affect theory and practice in marketing. Even so, it faces several challenges. In this article, we outline three common challenges and assert they can be addressed by (1) drawing inferences that extend beyond simple brain–behavior correlations, (2) building on recent work that provides statistical grounding for behavior-to-brain inferences, and (3) focusing on the reliability and generalizability of findings to the general population (for a more extensive discussion of other challenges, see Smidts et al. 2014).

There is much cause for optimism about the future of consumer neuroscience. As the contours of the field continue to evolve, we will undoubtedly see exciting technical advances in neuroscience methods and important contributions that add value to our understanding of consumers. Recently, it has become more common to apply multivariate techniques such as pattern classification (Haynes and Rees 2006; Norman et al. 2006) to predict decisions (Clithero, Carter, and Huettel 2009; Clithero et al. 2011; Tusche, Bode, and Haynes 2010). For example, Smith et al. (2012) use such an approach to predict out-of-sample choices from “nonchoice” neural responses to different products, and Chua et al. (2011) do so to predict quitting behavior of smokers four months later. We contend that the resulting models that are predicated on underlying neural mechanisms will prove more robust to new situations and contexts than traditional market research methods such as focus groups and surveys (Venkatraman et al. 2012). Moreover, they have the potential to be scalable to real-world outcomes that provide an opportunity to generate deeper understanding about consumers and to inform marketing decisions with practical and economically significant consequences.

Consumer neuroscience, considered broadly, has contributed to a systematic understanding of how consumers value items. We know more about the valuation circuitry in the brain, for example, and thus have the opportunity to map models of valuation at various stages of the decision-making process onto models of behavior. This provides a sound basis for investigating theories and hypotheses about the antecedents, consequences, and moderators of consumer valuation that have fidelity with respect to biology. Further research holds the promise of similarly sharpening our understanding about consumer processes underlying information processing and decision making, such as attention, memory, and emotion—domains that cut across traditional areas of cognitive and affective neuroscience. These more mature fields are continually reaching new levels of sophistication with respect to theories and techniques that constitute a valuable resource for consumer neuroscientists who aim to develop theories that account for biological substrates. Adopting a neuroscience-based approach holds the promise of setting the stage for conceptual developments offering potentially revolutionary insights about consumers that are not necessarily constrained by traditional views of memory and information processing (e.g., multiple systems, different stages, semantic networks).

We believe that our overall enthusiasm for consumer neuroscience is broadly shared. The past decade has seen a steady growth of consumer neuroscientists conducting research in business schools. There now exists a critical mass of consumer neuroscientists who have the necessary expertise not only to generate high-quality work and provide graduate-level training but also to serve as referees for marketing journals. They comprise an active and supportive community of scholars who are dedicated to the goal of producing and disseminating neuroscientific knowledge that enhances understanding of consumers. We expect this community to thrive as the field moves forward. As important findings continue to emerge, we will see an increasing number of methodological developments and innovations that represent significant markers of advancement.

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