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Consumer neuroscience: advances in understanding consumer psychology

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While the study of consumer behavior has been enriched by improved abilities to generate new insights, many of the mechanisms underlying judgments and decision-making remain difficult to investigate. In this review, we highlight some of the ways in which our understanding of consumer psychology has been, and can be, advanced through the use of neurophysiological methods. In particular, we outline some of the common neural circuitry that is involved in affective processing, subjective value, persuasion, and attention. We discuss how an understanding of these mechanisms can be used to better elucidate various elements of consumer psychology. We show how recent findings have produced a deeper understanding of decision-making, and suggest directions for future research.

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Introduction

Over the last several decades, there have been remarkable innovations allowing us to consider different ways of understanding and modeling consumer behavior. For example, digital and mobile advances in tracking marketplace activity have opened up one source of data, with analytics that can reveal not only patterns of behavior, but also examine how small changes in marketing actions affect them. These methods have proven themselves to be a tremendous source of information. At the same time they notably retain the 'black box' perspective — modeling behavior independent of attempting to understand the underlying processes.

The entrance of neurophysiological methods into this field has, however, offered additional dimensions of insights into the psychology and mechanisms that drive behavior. Whereas early foundational work in consumer neuroscience explored how value and marketing-related concepts are represented in the brain, this field has now grown to allow sophisticated measurement of consumer responses to price, brands, persuasive messages, and a range of other marketing-related factors (see [1–3] for other recent reviews).

The present review provides selective coverage of advances in consumer neuroscience in domains such as affective processing and estimates of value in choice. We also discuss how neural insights can offer a more nuanced understanding of persuasion and attention that can be difficult to capture via behavioral metrics alone. Throughout this review, we highlight some of the findings that have provided a strong foundation for the field, and have forged new paths toward an improved understanding of consumer psychology.

Affect, preferences, and motivational processes

In terms of both theory and practice, one of the most promising areas for consumer neuroscience to offer insights is in affect and/or emotional responses. Affect is notoriously difficult to capture accurately through methods like surveys or introspection [4]. The continuously dynamic and relatively non-intrusive nature of many neurophysiological measures allow for ways to better understand how consumer emotions change over time, and are, or are not involved in decision-making [5].

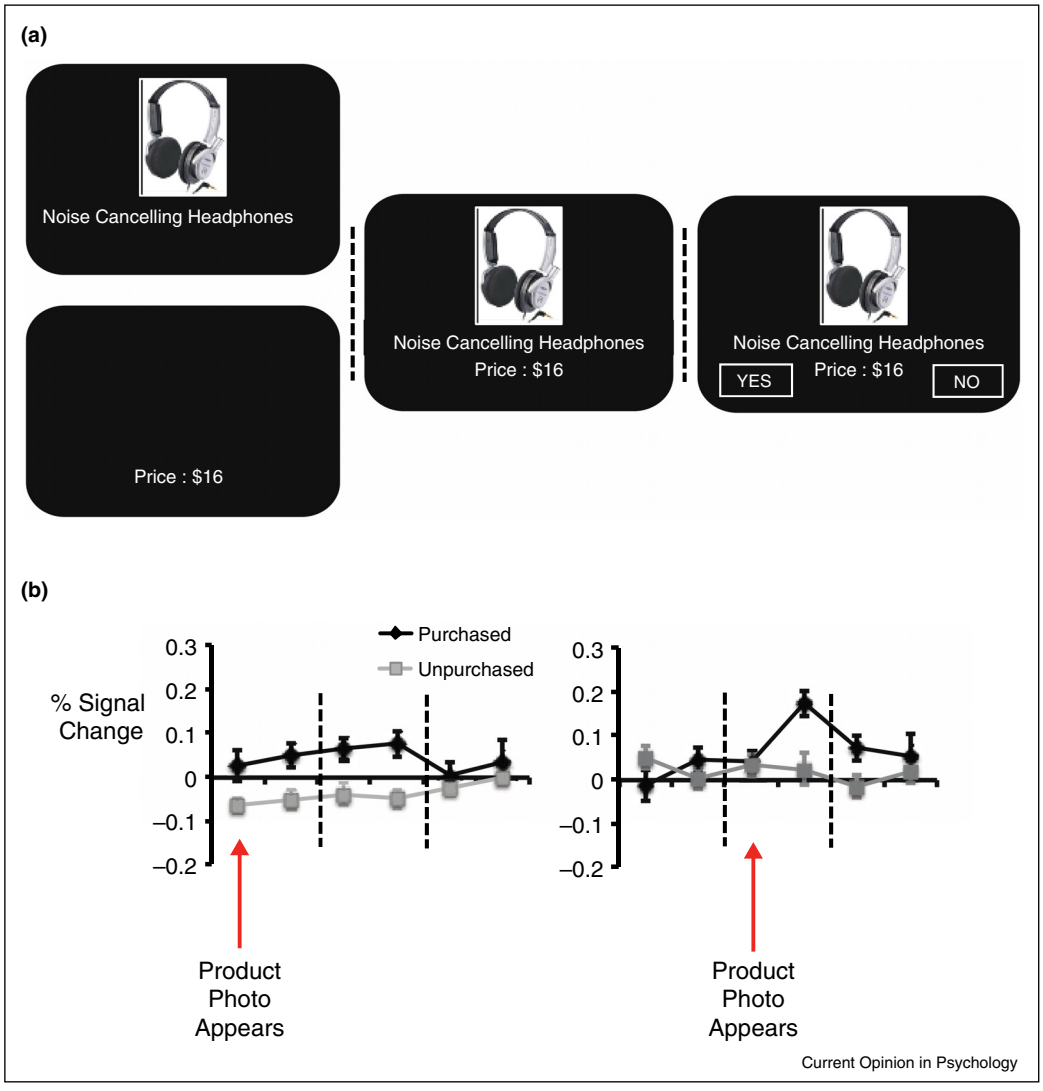
A potentially useful way to conceptualize affective processing from a consumer neuroscience perspective is to draw on an affect-integration-motivation framework (AIM) [6]. According to the AIM, affect can be viewed in terms of subjective arousal and valence [7]. It posits that separable neural circuits (nucleus accumbens (NAcc), insula) first affectively evaluate objects. These evaluations may then be integrated with considerations of specific situational or conceptual information (in the medial prefrontal cortex (MPFC)) and translated into motivation to approach or avoid the object.

The NAcc is a key neural area for understanding that first step of affective processing. Given its location deep in the brain, fMRI is the primary technique used to track NAcc activity in humans. Activity in this brain region has been correlated with positive subjective arousal and is often accompanied by motivation to approach opportunities. In the context of consumer neuroscience, the NAcc has been

shown to reflect how much people like a product, or how attractive they find it [8,9,10••]. It is notable that this affective response is separable from the more comprehensive estimate of value (discussed in the next section). For example, in a purchasing context, consumers may learn of various product attributes, like price, or discounts before they actually see the product (e.g. coming across it in person or viewing a photo on the screen online.) However, studies have found that the onset of NAcc activity occurs only at the time when consumers are viewing the product itself [9,10••] (Figure 1). As such, it appears to specifically reflect an emotional attraction that may or may not be influenced by some of the elements of the marketing mix, like price, or promotion.

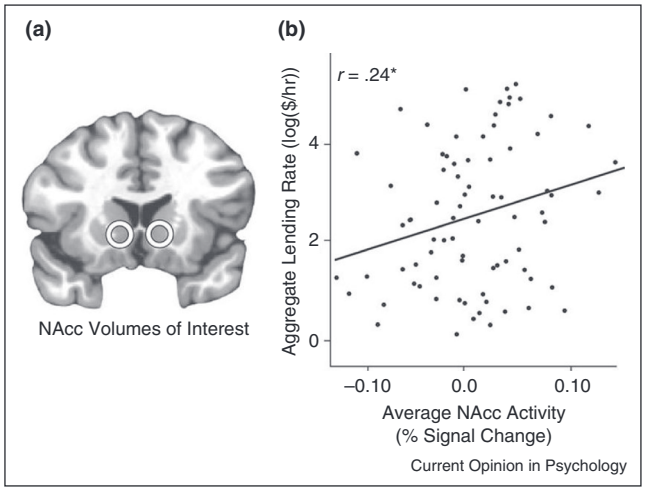
This interpretation of NAcc activity has potentially significant implications for identifying and measuring the contribution of affect in consumer behavior. In particular, a series of recent findings have shown that NAcc activity can predict market-level choice outcomes across different decision contexts like music box-office sales [11•], microlending [12••] (Figure 2), and crowdfunding [13]. A notable element of these studies is that in contrast to 'big data,' this predictive power is possible using fMRI data from relatively small samples (e.g. $n = 30$). In addition, predictions from the neural data significantly outperform the predictions from preference measures obtained from traditional surveys collected at the same time from the same individuals. Along similar lines, NAcc activity in response to advertisements has also been

Figure 1



(a) Experimental design in which products appear before or after price information during the decision process; **(b)** timecourses for nucleus accumbens (NAcc) activity for purchased versus unpurchased products in this experiment.
Adapted from [10••].

Figure 2



(a) Location of the region of interest in the nucleus accumbens (NAcc) where activity (percentage signal change) during presentation of the microloan positively correlated with aggregate lending rate; **(b)** scatterplot (with best-fitting regression line) showing the aggregate lending rate as a function of averaged NAcc activity. Adapted from [12••].

shown to predict (beyond behavior) market-level sales [14••]. An important question for future consumer research raised by these studies is why neural data, and the NAcc in particular, outperform consciously expressed preferences. In particular, could NAcc activity capture other dimensions comprising emotional responses, or an element of preferences that generalizes well across the population?

Another neural region significantly involved in affect, arousal, and motivation is the insula. Broadly speaking, both positive and negative arousal and affect have been associated with areas in the anterior insula (AI) [15]. For example, consumer sensitivity to risk and/or harm, particularly in financial domains, has implicated the AI. In studies of risky decision-making, AI activity has been associated with anticipation of risk [16] and losses [17], aversion to financial risk [18], and harm avoidance [19].

These findings, taken together, suggest that it is possible to simultaneously track emotional responses to both preferences and risks with neural methods. An additional fascinating question is whether valenced arousal and affect can be inferred directly from the brain areas in the NAcc and AI networks [6,20] (but see also [21]). However, it is important to bear in mind that while focusing on specific brain areas can offer a useful scaffold for discussing affect in decision-making, this limited representation of the circuitry is not exhaustive or definitive in representing how emotions influence decision-making across the brain.

Valuation, price and choice

Beyond the relatively simple decision elements considered in the previous section, more complex decisions likely require integration of these basic responses with other considerations. Prior research suggests the prominent role of MPFC in the integration process (cf. [6]). The ventromedial prefrontal cortex (VMPFC), in particular, includes a set of interconnected regions that integrate information from affective sensory and social cues, value, long-term memory, and representations of the 'self'.

A fairly extensive body of research in neuroeconomics has demonstrated that activity in VMPFC correlates with subjective utility [22]. For example, VMPFC encodes the valuation of different types of outcomes central to consumer behavior such as eating, drinking, shopping, and financial decision-making (e.g. [17,23–26]). Neuroimaging studies have implicated VMPFC in measures of both the process and outcomes of valuation from different modalities (see meta-analyses [27,28]).

Indeed, VMPFC signals appear to represent an item's decision value when a choice is hypothetical [29] or even when no decision is currently needed [30–33]. These findings offer useful insights to marketers designing retail and other purchasing contexts, who might want to consider how their items are being encoded even when they are not actively part of a consumer's choice. For example, it suggests that display-only or cross-promoted products might not simply be engaging people's attention, they might also be establishing the relative value of those other items as part of a choice.

If we consider how this relates to consumer purchasing behavior, MPFC and proximal areas in medial orbitofrontal cortex (MOFC) have been shown to positively correlate with monetary estimates of value such as willingness to pay for items [9,10••,24]. As such, prefrontal activity offers a useful signal of the integrative value of a marketplace offering, and particularly a consumer's relationship with price. For example, activity in the MPFC has been used to detect changes in how value is estimated when people view price information earlier [10••] or have to consider prices when in the role of seller versus buyer [34] (but see also [35]). Furthermore, an understanding of 'price placebo' effects, in which knowledge of a price can influence the reward value of a product or experience, was supported by related activity in the MOFC [24].

While the price-related elements of a choice might seem more cognitive, emerging evidence suggests that VMPFC is involved in integration of affective signals with self-relevant considerations to trigger motivation and behavior (e.g. [13]). The VMPFC is also a central target of regulatory or self-control mechanisms. Thus, from a motivational perspective, circuitry that impacts the VMPFC can be

critical in understanding consumption decisions related to goals such as diets [36•,37].

Taken as a whole, MPFC is likely to be a critical region of interest for consumer neuroscientific investigations, as it may offer opportunities to examine how value is dependent on the contexts created by specific marketing actions.

Persuasion

In addition to the contributions that consumer neuroscience has made to our understanding of affect and valuation, it is also able to offer significant insights in the domain of persuasion and communications [38]. Interestingly, beyond representing how a person thinks about the value of external stimuli, VMPFC is centrally implicated in 'internal' or self-referential processing as well [39,40].

Indeed, VMPFC is commonly engaged in self-related processing when persuasive messages are tailored and personalized to the individual and thereby deemed more relevant to the self [41]. Self-affirmation also increases activation in the VMPFC, which in turn leads to greater behavior change [42].

Since these findings seem intimately related to an individual's self-perception, it is less obvious that prefrontal cortex might offer significant 'out-of-sample' prediction of other's behavior. However, VMPFC activity measured in a small group of participants is able to predict population-level consumer responses to persuasive health advertisements, and does so better than behavioral prediction, or the predictions of advertising experts [43]. Given that only VMPFC was predictive, it offers an interesting contrast to findings in which NAcc is the only brain area with significant predictive power related to purchasing (e.g. [11•]) or in which more diffuse networks measured by EEG can predict other forms of market-level media consumption [44]. This raises an important question for future studies about whether there are meaningful distinctions between neural prediction for persuasive messages related to self-focused goals and motivations (e.g. in the health domain) and neural prediction for persuasive messages related to purchase of goods, experiences, and commercial services.

Attention

A fourth domain in which neurophysiological measures offers useful insights is in understanding how consumers allocate their attention, particularly visual attention. While fMRI has been a dominant methodology in consumer neuroscience, one of the most useful tools for understanding visual attention is eye-tracking. Work in this field has shown that visual salience can override preferences in determining choices that are made under time pressure, or under cognitive load [45]. For example, imagine stopping into a store quickly to buy a candy bar. These findings suggest that a shinier wrapper can distract you away from the option you actually prefer. In addition, eye-tracking studies have shown that looking at something for longer can actually increase the likelihood of buying it [46], and that integrating visual salience and subjective value can improve the understanding of choice [47].

Notably, the advances made in visual attention have been significant enough to cross over from theory to practice. For example, based on an extensive understanding of visual attention, it has been possible to build models that can accurately predict the degree to which visual elements of a scene will capture attention [48]. Building on this, a sophisticated prediction algorithm developed from a deep scientific understanding of visual processing is used by the firm EyeQuant, which offers clients a 'visual attention analysis' of their website offerings [49].

Conclusion

Integrating findings across multiple methods and linking neuroscience with consumer research promises to continue improving our understanding of consumer behavior in established (e.g. retail) and more recent channels (e.g. online [50]). The complexity of consumer behavior requires consideration of multiple related mechanisms rather than more specialized brain regions. The fact that multiple functions are coded across the brain means that it is difficult to infer a specific psychological process from activity in one particular brain area [21,51]. However, this distributed and non-exclusive functionality also points to the potential benefits of measuring neural activity — the ability to examine consumer behavior in a nuanced way across multiple brain areas that are sometimes more informative than responses elicited using behavioral measures. Consumer neuroscience therefore offers an opportunity to complement traditional research methods and more recent analytics with insights into underlying mechanisms that are not accessible via self-reports or large-scale observations.

Conflict of interest statement

Nothing declared.

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- • of special interest
- •• of outstanding interest

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Participants in an incentive compatible fMRI study decided whether or not to purchase a number of popular retail items. For each choice, a photo of the product appeared before (product primacy) or after (price primacy) the price was shown. The value of the products (related to willingness to pay) correlated with activity in MPFC after both price and product information were seen. Though price primacy did not cause an overall increase or decrease in MPFC activity, it caused a relative change in the way that value for purchased and unpurchased items was encoded. The findings suggested that under product primacy, consumers made decisions based on the question 'do I like this product?', but that under price primacy, they shifted to asking 'is this product worth it?' This framework was validated by testing its predictions in a subsequent behavioral experiment.

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This study is one of the first papers to document out-of-sample prediction for marketplace behavior from fMRI measures. It modeled how well behavioral and neural measures of music preferences from a small sample of adolescents ($n = 32$) could predict commercial success of the songs (as represented by data from Nielsen Soundscan). The study showed that activity in the nucleus accumbens (NAcc) significantly correlated with the sales data, but that behaviorally expressed preferences had no significant predictive power.

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In this paper, the authors analyzed a large number of real microloan requests on Kiva.org, and found that photographs of borrowers that aroused the greatest positive affect generated the highest levels of funding. In a neuroimaging study, they documented a decisive link between positive affect and lending by showing that self-reported positive responses to borrowers' facial expressions and the corresponding nucleus accumbens (NAcc) activity predicted higher market-level lending rates. In other words, neural predictions of microlending scaled to market-level outcomes.

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The authors examined responses to 37 advertisements using multiple traditional methods (e.g. surveys, implicit attitude tests) as well as multiple neural and biometric methods (fMRI, EEG, eyetracking). Real world advertising success was then measured using sales elasticities. Modeling this data revealed that while behavioral measures did significantly predict of these elasticities, fMRI data, and in particular activity in the nucleus accumbens (NAcc), was the only neurophysiological measure to explain a significant amount of additional variance.

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