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The Neuroscience of Consumer Choice

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Abstract

We review progress and challenges relating to scientific and applied goals of the nascent field of consumer neuroscience. Scientifically, substantial progress has been made in understanding the neurobiology of choice processes. Further advances, however, require researchers to begin clarifying the set of developmental and cognitive processes that shape and constrain choices. First, despite the centrality of preferences in theories of consumer choice, we still know little about where preferences come from and the underlying developmental processes. Second, the role of attention and memory processes in consumer choice remains poorly understood, despite importance ascribed to them in interpreting data from the field. The applied goal of consumer neuroscience concerns our ability to translate this understanding to augment prediction at the population level. Although the use of neuroscientific data for market-level predictions remains speculative, there is growing evidence of superiority in specific cases over existing market research techniques.

Introduction

At the heart of all commercial and economic activities is the consumer, whose preferences and choices heavily influence a host of decisions and actions by entrepreneurs, firms, and governments [1]. These choices range from weighty ones such as purchasing a home to routine ones such as grocery shopping. Scientifically, theories of consumer choice are foundational to a number of fields in the social and biological sciences [1–3]. In applied settings, governments and companies expend considerable sums to forecast individual-level and aggregate choices and to shape preferences [2].

In recent years, researchers working in different fields, including psychology, economics, neuroscience, and marketing, have sought to systematically examine neurobiological mechanisms underlying consumer preferences and choice processes. These findings have been reviewed in a number of journals from both neuroscience and consumer research perspectives [4*,5–8], including how pricing, branding, and advertising affect consumer choice, as well as attempts of both academic and industrial researchers in translating this

neural understanding to improving accuracy of market-level forecasting based on existing techniques.

Therefore, rather focusing on past findings, we will discuss some important open questions that are only beginning to be addressed in the literature. Using an ordinary grocery-shopping trip as a motivating example, we consider two sets of questions at the intersection of consumer research and cognitive neuroscience. First, how are consumer preferences formed and represented in the brain? In particular, how do we characterize the complex interaction and contribution of social, cultural, and developmental processes to preference formation? Although we know much about the developmental trajectory of consumer preference formation on the one hand, and those of neurocognitive processes on the other, there is as of yet little attempt to understand how the latter serves to shape and constrain the former.

Second, what are the roles of attention and memory processes in translating preferences to choice behavior, particularly in naturalistic settings (Fig. 1)? For example, how do consumers and their brains respond to complex communications and marketing stimuli in modern societies (e.g., ads, websites, packaging), and how do they engage in specific tasks (e.g., search, choice, usage)? Here too, despite ample documentation of the importance of consumer attention and memory in real-world behavior, we know little about the underlying neurocognitive processes involved. Finally, we then turn our attention to issues surrounding the commercial application of the neural-level knowledge to forecast aggregate consumer behavior at the market level, including questions related to its feasibility and impact.

The Science Of Consumer Choice

Over the past decade, we have learned an immense amount about how the brain weights costs and benefits associated with acquiring goods to satisfy preferences, and how it responds to factors such as the delays associated with the arrival of goods and the uncertainty with which these goods arrive [9,10,11**]. An integral part of this effort has been the application of functional neuroimaging techniques to a simple yet powerful framework where people make decisions by evaluating and maximizing subjective value associated with competing alternative [12–14]. However, it remains challenging for this knowledge to provide a mechanistic account of even relatively simple acts such as purchasing a breakfast cereal.

Where Do Preferences Come From?

First, existing studies have largely avoided addressing the complexity and richness of consumer preferences and choice in contemporary culture. That is, how are preferences for products and brands represented and organized by the brain, how they are shaped by external forces, and how do they develop and change over the course of the lifespan?

This omission in part reflects an inherent limitation of standard models of decision-making, which impose strong conditions on the ordering of preferences and provide little insight into the actual contents of the preferences or how they are organized at the neural level [16]. For example, so long as the consumer is consistent in her choices of breakfast cereals, current models would have little to say about the specific cereal a consumer might buy, and

similarly find nothing odd if the consumer were to pour orange juice on her cereal. Ironically therefore, current advancements in understanding valuation and choice processes have resulted in only modest advances in understanding the actual content of preferences.

An early example demonstrating the powerful effects of cultural and social influences on the brain came from a laboratory version of the Pepsi Challenge, where it was shown that knowledge of the brand biased behavioral preferences away from Pepsi and in favor of Coca-Cola [17**]. At the neural level, behavioral preferences was found to be correlated with activity in ventromedial prefrontal cortex [17–19], and that furthermore damage to this region abolished the biasing effects of brands [20*]. Since then, a number of studies have additionally documented the influence of value representations to factors such as price [13,14**], as well as the cognitive processes that might give rise to abstract intangible characteristics such as brands [15,16**,17].

In addition, consumer researchers and developmental researchers have long noted the importance of developmental processes in the formation of preferences. Children, for example, appear to develop quite early on sophisticated knowledge of environmental stimuli such as brand logos, and are able to recognize them by as early as 3 years old [26]. This is even so for products that they are unlikely to have direct experience in consuming, such as cigarettes [27]. Furthermore, underscoring the interaction between developmental and social processes, some consumption domains, such as musical taste, are strongly related to an individual's age at the time a song was popular, with the strongest relationships for pieces that were hits when the respondent was in late adolescence or early adulthood (23.5 years of age) [28] (Fig. 2).

These findings correspond well to what is known about the neurodevelopmental trajectory of motivational systems in humans and model organisms, particularly the importance of certain critical windows during adolescence and early childhood [29]. Reward-related regions of the brain and their neurocircuitry, for example, is known to undergo particularly marked developmental changes during adolescence, and their disturbances have profound effects on experimentation and consumption of alcohol and other drugs [30]. Similarly, works on model organisms have underscored the important interaction of parental care and neural systems in shaping organisms' behavioral responses to reward and punishment contingencies [31,32]. Further neuroscientific investigations combining consumer research and developmental insights may therefore be particularly useful in shedding light on fundamental scientific questions related to preference formation and public policy issues associated with them.

Choice Processes

A second set of questions still poorly understood concerns the complex interaction of attention, memory, and valuation processes in consumer choice [33]. In particular, because much of actual consumer choices are made in scenarios where the consumer relies in important ways on memory or search, conclusions based on studies using typical laboratory paradigms, where all relevant alternatives are provided, can be misleading [33,34].

Returning to the example of our grocery shopper, she may fail to pay attention to all possible brands, and instead consider only those on the shelf at eye-level since it takes too much time to consider all possible cereal brands [35–37] (Fig. 1). That is, the consumer may prefer brand x to brand y, but instead choose y when x is present because she does not realize that x is also available [38]. She may fail to consider any cereals at all because she has forgotten that she has run out of them at home. Or she may misperceive or misremember some key attributes regarding the cereal, perhaps mistaking claims of nutrition by one brand for another. Consumer research has shown that such misattributions are commonplace, and become more common with age [39].

Consumer theories focused on stages of processing provide a powerful way of characterizing the constraints on choice by memory and attention processes [33,34]. In particular, substantial evidence from field, laboratory, and eye-tracking data suggests that the consumers first filtering the available alternatives using relatively simple criteria and then undertaking detailed analysis of this reduced set [34,40] (Fig. 3). Specifically, prominent theories of consumer choice have proposed that, occupying between the space of the entire universe of available option and the final choice sits a so-called “consideration set,” which consists of the set of alternatives considered immediately prior to choice [35*, 41].

Consistent with the idea that most people consider far fewer than the total number of products available, past studies have found that the size of consideration sets to be in the range of 3 to 6 [41]. Furthermore, models that incorporate consideration sets have been found to explain choice data substantially better than standard models using choice data alone [35]. More generally, such “phased” decision strategies have been suggested as representative of human decision-making in a number of contexts where consumers have to cope with complexity [2,42].

Neuroscientific investigation of how attention and memory processes influence valuation processes in naturalistic contexts is only beginning, with early evidence pointing to the role of striatum, dorsal ACC, and insula in responses to variations in consideration size [43]. Functional connectivity analyses to map networks (e.g., salience network, executive-control network) that can be reliably associated or dissociated with performance on specific tasks may thus help inform a better understanding of consumer choice processes at the neural as well as holistic levels. Alternatively, multivariate decoding approaches can be used to provide direct evidence of the existence of consideration sets in ways that are independent of choice sets and choices themselves [44].

From the Laboratory to Commercial Applications

Since its early days, industry has followed developments in consumer neuroscience with great interest. In particular, neuroscientific methods offer hope for solving a core issue for many marketing researchers: how to reliably measure reactions to commercial offerings that consumers are either unable or unwilling to articulate [7]. In addition to the growing number of neuromarketing companies [46], a leading neuromarketing company, Neurofocus, was

acquired by Nielsen in 2011, which may be viewed as a signal that an industry leader in marketing research sees value in the neuroscientific approach.

An important hurdle in assessing the validity of the claims made by industry practitioners is the closed nature of the technology of most existing offerings. Despite this, there is growing evidence from the academic literature that, at least in certain cases, neuroscientific methods indeed provide additional information compared to traditional market research techniques. Beginning with early studies demonstrating the feasibility of using neuroscientific data to predict consumer choice [15*,47,48], more recent students have leveraged advances in analytical techniques, such as multivariate methods to improve upon these prediction rates [49*,50,51]. Further improvements will undoubtedly continue given rapid pace of advances in analytical and technological sophistication.

Moreover, there are encouraging signs that issues of validity and reliability are increasingly being taken seriously by industry. For example, the Advertising Research Foundation (ARF) has taken an early interest in considering the added value of neuroscience techniques to advertising. In the ARF's NeuroStandards 2.0 initiative, preliminary results from teams of independent academic researchers indicated that while traditional measures are still good predictors of commercial effectiveness, fMRI measures are able to improve significantly upon those predictions [42**]. These results dovetail with recent findings that "neural focus groups" may contain information that can predict out-of-sample behavior and market success beyond information obtained from conventional self-report methods [53*,54].

Conclusions

The study of behaviors related to the choice, purchase, and use of goods and services have long attracted diverse collection of ideas and techniques, including those from psychology, economics, marketing, and increasingly, neuroscience. In this review, we start from the set of adaptive problems facing modern consumers and review what is known about the rich repertoire of cognitive processes that shape and constrain these behaviors, as well as their neural substrates. We argue that such a perspective highlights some salient gaps in our current knowledge; in particular neurodevelopmental processes involved in preference formation, and the role of attention and memory systems in consumer choice. Given the extent to which products and cues dominate the modern consumption environment, capturing neurocognitive processes involved in naturalistic choice settings will be critical to understanding behavioral disturbances and disorders including obesity, addiction, and compulsive behaviors. Research on the neuroscience of consumer choice therefore holds much promise to inform and elucidate not only consumer behavior, but to advance the neurosciences in general that can ultimately lead to interventions for addressing problematic outcomes.

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Highlights

1. Consumer neuroscience studies questions of both a scientific and commercial nature
2. Studies of scientific nature has focused on neurobiology of choice processes
3. Further advances require incorporating developmental, attentional, and memory processes
4. Commercial interests in consumer neuroscience has been increasing in recent years
5. Growing evidence of value of neuroscientific techniques in market-level predictions

Fig. 1.

(A) Typical laboratory consumer choice paradigm [Adapted from 4*], **(B)** Typical consumer choice scenario.

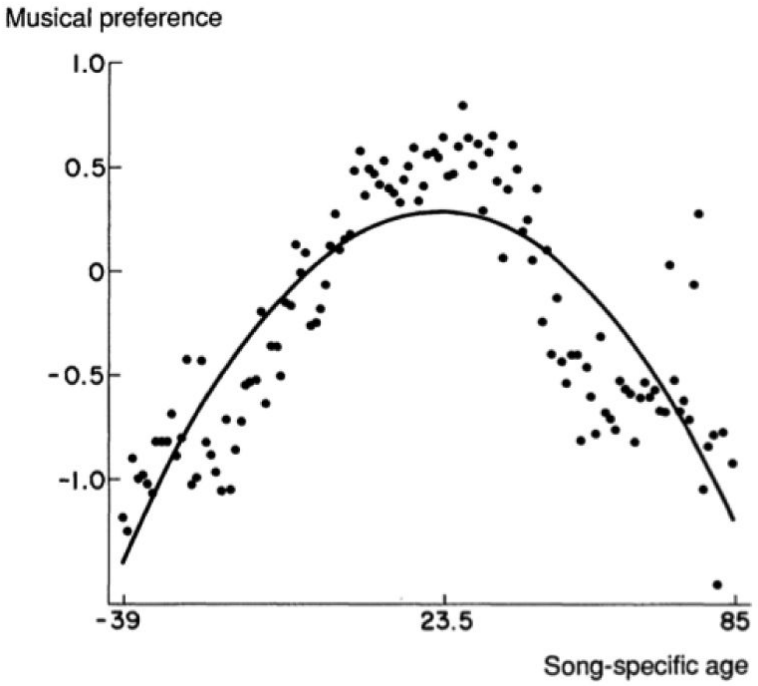

Fig. 2.
Relationship between song-specific age and musical preference [Adapted from 28].

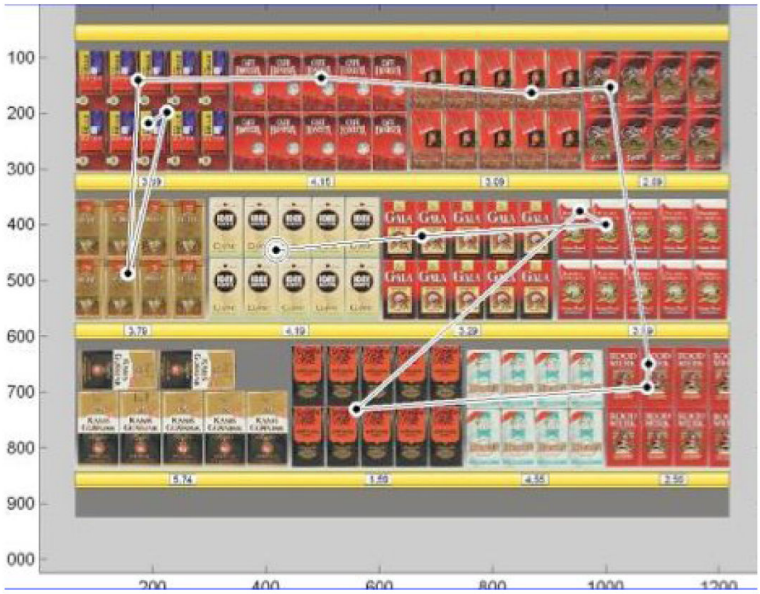

Fig. 3.

Computer simulated store shelf with overlaid eye movement pattern for a single trial. Consumer attention captured by gaze patterns was found to be significantly affected by low-level perceptual features independently of primary product features [45].