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METHODS DIALOGUE

# Commentaries on "Reconsidering the path for neural and physiological methods in consumer psychology"

**J. Wesley Hutchinson**[1] | **Martin Reimann**[2] | **Brian Knutson**[3] | **Joel Huber**[4]

[1]Wharton School, University of Pennsylvania, Philadelphia, Pennsylvania, USA

[2]Eller College of Management, University of Arizona, Tucson, Arizona, USA

[3]Department of Psychology, Stanford University, Stanford, California, USA

[4]Fuqua School of Business, Duke University, Durham, North Carolina, USA

**Correspondence**
Joel Huber, Fuqua School of Business, Duke University, Durham, NC 27706, USA.
Email: joel.huber@duke.edu

**Abstract**

The initial version of the article by Clithero, Karmarkar, Nave, and Plassmann (Journal of Consumer Psychology, 2024) was critiqued by open comments from a small group of scholars. Their suggestions encouraged the authors to clarify challenging relationships between brain processes and emotions, beliefs, and actions. The revision expanded fMRI and EEG to include measures of vision, facial expression, breathing, heart rhythms, and blood chemistry. The paper provides multiple avenues of joint work between neurological and psychological scholars. The comments below reflect different reactions to the final article. Wes Hutchinson acknowledges that neuroscience insights complement cognitive measures that generate explicit measures of thought, emotion, or preferences, but he warns that repeated measures over time are problematic for both types of measurement, and the inherent complexity of brain–behavior relationships is often underestimated. With both orientations, understanding the functioning of human behavior is akin to making sense of an orchestra, where the interactive blending of different instruments and musicians reflects a complex activity that generates sounds, emotions, and stories. Both consumer neuroscientists and psychologists need to broaden their paradigmatic approaches with bodily measures and advanced psychological procedures to overcome challenges to joint progress. Martin Reiman asserts that despite difficulties with measures that have different levels of abstraction or velocity, research has provided remarkable associations between brain activity and consumer behavior. Effective studies merging brain and behavior can effectively proceed with studies that differ in two dimensions: first, by altering the number of variables, and second, by shifting whether the scientific paradigm is inductive or deductive. In its simple form, the Excavation path explores brain activity when a person is exposed to specific statements or emotions. In its most challenging form, Integrative Studies generate predictions from theories that test the convergent validity of divergent measures and leverage skills from different researchers. Studies reflecting high levels on one dimension but low levels on the other can also provide fruitful research opportunities. Brian Knutson, like Reimann, counters the idea that consumer psychology has not lived up to its promises. He references studies showing that activity from very specific areas of the brain reliably predicts choices better than explicit ratings or choices. Such research generates deductions from increasingly precise neural maps that enable confirmation of theory. That said, he acknowledges that consumer neuroscience is not able to identify a brain button that would alter choice through manipulated neurostimulation. However, since human brains are similar across people, the depth of neural insights that are consistent across a small sample of 40 respondents may generate greater insights than conventional marketing research

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with 2000 respondents. The cost of neuroscience will further decrease with gains in reliability, validity, and generalizability, particularly if augmented with bodily measures. He acknowledges that the theoretical side has developed more slowly than applications, particularly applications that are supported by sponsoring organizations more satisfied with local insights than general models.

**KEYWORDS**
consumer, dialgue, neuroscience, psychology

# PROBLEMS AND PROSPECTS FOR NEURAL AND PHYSIOLOGICAL METHODS IN CONSUMER PSYCHOLOGY

J. Wesley Hutchinson
University of Pennsylvania

Basic neuroscience made steady progress throughout the 20th century with only small areas of application outside of medicine. Over the past 40 years, however, breakthroughs in measurement and computation have accelerated basic research and created major applications for business and technology. Currently, applications to marketing research, advertising, and product development are experiencing explosive growth that has been met with both excitement and skepticism. These applications are sometimes called "neuromarketing" (although this term has a somewhat negative connotation in the United States). This growth parallels the growth in academic research and commercial marketing research. In both areas, the methods of neuroscience (broadly defined) have proven to be a very useful toolkit for "implicit" (non-conscious) measures that complement the traditional "explicit" research methods (e.g., survey, click-stream, and purchase data).

Clithero et al. (2024) have provided a useful overview of neuroscience methods and how they could contribute to consumer psychology, and an insightful assessment of the "slow" adoption of neuroscience methods by consumer researchers (which contrasts with the growth in other academic areas; e.g., neuroeconomics). The latter contribution is the focus of my commentary. There are five parts. The first three are reflections on the three factors Clithero et al. (2024) identify as causing slow adoption. They also propose some promising solutions to these problems. The final two parts of this commentary are somewhat broader factors that I think contribute to slow adoption, and for those, I am not optimistic about solutions. Most of what I say is based on the Consumer Neuroscience course I taught from 2015 to 2017 and, to a lesser degree, on my own early training in cognitive psychology and my more recent research activities.

## Process and measurement

Clithero et al. (2024) note that there is not a one-to-one mapping between neural and psychological processes, so their measurement methods may diverge in both the questions they address and the conclusions they afford. The classic work of Campbell and Fiske (1959) on the multitrait–multimethod approach to establishing convergent and discriminant validity immediately comes to mind in this context. Are the theories and methods used to investigate neural and psychological processes merely "ships passing in the night," or is there a larger framework that integrates the two and predicts when they should converge and when they should diverge? Clithero et al. (2024) use Marr et al. (1982; also classic) levels of abstraction framework (function, algorithm, implementation) as a good place to start, and I agree. However, the devil is in the details, and I will return to this issue later.

One devil I will mention now is that even at the same level and investigating the same problem, measurement methods can conflict and provide misleadingly divergent results. For example, consider the various ways consumer researchers have measured cognitive responses to persuasive communications (especially advertising). Academics have most frequently used thought-listing measures and then combined them with valence ratings to form a single measure of attitude. These are explicit measures, and therefore subject to a variety of biases. Practitioners have used a wider set of measures (including neuroscience measures such as eye-tracking and facial expressions) and have focused on specific reactions to elements of communication. This motivated Huang and Hutchinson (2008) to investigate implicit measures of specific cognitive responses using recognition and verification tasks for specific beliefs resulting from a communication; for example, "the Fiat Punto is fast" or "the Panasonic TV is expensive." We found that these implicit measures outperformed explicit measures in predicting attitudes. This task provided three related measures: the response (true or false), the reaction time for providing the response, and the rated confidence with which the belief is held. For a strongly held belief, it is natural to expect that the response would be "true," and it would be given quickly and confidently. Thus, we expect these to be convergent measures. We found this to generally be true. However, using a sequential sampling model that made predictions about all three measures, we showed that none of them were necessarily monotonic with the strength of the belief. The value of fitting the mathematical model to the data was that it provided an estimate of the latent parameter that represented

strength. The point here is that even within the same level of analysis, measuring a psychological process can be rather complicated. I would also note that sequential sampling models have been extensively used in cognitive neuroscience, but used by only a few consumer researchers - another example illustrating the primary claim of Clithero et al. (2024).

## Beyond brain imaging

Building on their first concern, Clithero et al. (2024) claim, and I agree, that consumer research has focused too exclusively on brain imaging (e.g., fMRI and EEG) and neglected other important brain-related measures (e.g., facial affective coding and skin conductance), experimental manipulations (e.g., pharmacological manipulations of hormone levels), and sources of individual differences (e.g., metabolic rate and genetic predispositions). They use Marr et al. (1982) levels-of-analysis approach to show how psychological processes and neuroscience methods can be better understood and used. Their implied criticism of consumer researchers (and again I agree) is that we have the wrong mental model of the brain and behavior, which I call the car-mechanic model. We tend to think of the brain as a set of parts (sensory and motor cortex, prefrontal cortex, hippocampus, etc.) that have single unique functions, like car parts. Thus, brain imaging is like popping the hood and checking the fluid levels, battery, belts, etc. This is a bad mental model. A better mental model might be an orchestra. Orchestras have many people playing different instruments at different times that make different, partly unique, and partly identical, contributions to an ever-changing symphony under the guidance, but not control, of a single conductor, all following musical codes written by a single composer for each member of the orchestra. There is no space here to map out this analogy, so I leave that to the reader. The point here is that to understand the observed behaviors, i.e., the many symphonies played by an orchestra, we need to understand its many, complexly interrelated parts and this takes a wide variety of methods applied at many levels of analysis.

## A feasible on-ramp

Clithero et al. (2024) correctly note that even if one is convinced of the value of neuroscience in consumer research, it is a formidable task for a researcher not trained in these areas to get up to speed. They suggest (1) the development of neuroscience curricula tailored specifically for consumer research academics and (2) increased access to method boot camps, workshops, and summer schools akin to those developed to support other research skills. To these good suggestions, I would add (3) take an introductory course at your university (e.g., cognitive neuroscience) or (4) do-it-yourself by purposively reading well-regarded texts in cognitive neuroscience (e.g., Gazzaniga et al., 2014; Purves et al., 2013), neuroeconomics (e.g., Glimcher et al., 2009; Glimcher & Fehr, 2014), and consumer neuroscience (e.g., Ramsoy, 2015). To be honest, though, one has to be very motivated to do any of these. Personally, I was only motivated to do it after committing to teach a course in consumer neuroscience (my syllabus and lecture slides are freely available at https://www.dropbox.com/scl/fo/fq6d0kryoaledgcf4sx2q/h?rlkey=093hl5v5d12va873pj6aphma6&dl=0). Nothing puts the fear of God into you like the prospect of standing in front of a classroom of undergrads and MBAs and not knowing what to say. As for the on-ramp, I am optimistic that some combination of the above would succeed for any consumer researcher wanting to learn more.

## Culture wars in consumer research

My optimism wanes, however, when I consider the "dark side" of consumer research (or, for that matter, any form of academic research). Our research succeeds by being very, very narrow. We must address every aspect of the specific problem we are investigating. This powerful approach results in intellectual siloing. In consumer research, it seems to have led to intellectual xenophobia. Behavioral researchers are from Venus; quantitative modelers are from Mars. Even within these silos, cognitive psychologists and social psychologists speak different languages and read different journals. The same is true of analytic and empirical modelers. Neuroscience seems to have (necessarily) embraced a wide range of academic disciplines (arguably by anointing a small subset in each to be the training common ground). In the best of possible worlds, consumer neuroscience could lead consumer researchers out of our silos; in the worst of possible worlds, it would just add motivation to reinforce the walls.

## It's complicated

Here is my understanding of the general model of the brain. The details are the subject of much debate, but the general model is widely held by most neuroscientists. There are myriad patterns of energy fluctuations in the external world. A small portion of these fluctuations are converted by sensory receptors into afferent neural signals. A small portion of these "bottom-up" neural signals are integrated into the brain with "top-down" memories, beliefs, and goals to update internal representations of the world and generate intentions for actions. Intentions for actions are translated into efferent neural signals to muscles that, in turn, cause muscle movements that create new patterns of energy fluctuations in the external world. Neuroscientists continually find that this chain of

events is not a singular flow, but is richly interconnected over both short and long time periods. It's complicated. Currently, consumer researchers, and especially journal editors and reviewers, love simplicity; however, Occam was wrong!

As an example, early in the history of cognitive neuroscience people thought that the brain was like a computer (and this analogy is still often made today). More accurately, the brain is like 85 billion interconnected analog-to-digital computers (i.e., neurons) operating in parallel, each receiving direct input from about 10,000 other computers. Thus, there are about 850 trillion synapses in the brain. There are about 200 billion stars in the Milky Way, and 1 trillion in Andromeda. Arguably, the simplest theory of brain function is Hebbian learning (Hebb, 1949)—often summarized as "cells that fire together wire together." This principle is still in use today (e.g., neural networks, unsupervised learning, etc.), but (a) cannot account for everything and (b) even if true at a general level, it leaves much-remaining work to do when the plasticity of 85 trillion synapses must be explained.

In conclusion, we need to find a way to deal with the complexity of integrating the methods and models of neuroscience into consumer research, but as I said at the outset, I am not optimistic.

## FOUR PATHS OF CONSUMER NEUROSCIENCE

Martin Reimann
University of Arizona

Clithero et al. (2024) assert that consumer neuroscience "has thus far not lived up to its promises in the marketing literature" and its path should be reconsidered. Do these assertions perpetrate an injustice against the field's collective achievements? This commentary highlights how consumer researchers have fruitfully taken four paths of consumer neuroscience to generate new knowledge, starting with the first original fMRI work published in consumer research by Yoon et al. (2006) to the most recent one by Wiggin et al. (2019). It is thus important to assess how exactly consumer neuroscience has home-grown from within consumer research and to acknowledge the joint insights this work has brought to the table. Because fMRI is the workhorse methodology of consumer neuroscience, this commentary focuses on fMRI work published in consumer research journals, some of which have not been discussed by Clithero et al. (2024). In addition, there is seminal marketing-related fMRI work published outside of consumer research (cf. Cao & Reimann, 2020 for a comprehensive review). Collectively, these insights have gradually enriched our understanding of consumer behavior.

Clithero et al. (2024) also state that neural measures have often been mistaken for psychological variables, suggesting they have nothing to do with one another. They are separate things, yes, but whether or not they are associated with one another is a conceptual and empirical question. To recall, fMRI measures blood oxygenation of brain areas, say the insula, which serves as a measured indicator of neural activity. One latent psychological variable theorized to be associated with blood oxygenation of the insula is bodily feelings, perhaps brand love (Reimann et al., 2012). Such mapping of measure on the construct is not qualitatively different from psychometric consumer research in which measured indicators such as "How content are you right now?" have been associated with conceptually related psychological variables such as happiness, amusement, or relaxation. As Bollen (2002) puts it, "(t)he idea that observable phenomena are influenced by underlying and unobserved causes is at least as old as religion, where unseen forces affect real world events (p. 606)."

The journey of consumer neuroscientists, from neurophysiological indicators to latent psychological variables (and vice versa), encompasses various routes. To categorize the different paths consumer neuroscientists have taken, this commentary integrates Campbell and Fiske (1959)'s seminal multimethod approach with (Lynch Jr. et al., 2012) distinction between inductive reasoning (i.e., drawing conclusions from patterns of observations, which can lead to new theory) and deductive reasoning (i.e., starting with theory and then testing specific hypotheses that were derived from it). The multimethod approach is helpful for improving *convergent* validity, referring to a variable's "confirmation by independent measurement procedures" (Campbell & Fiske, 1959, p. 81). For example, a latent variable can be cross-validated using different neurophysiological and psychometric measures (Wiggin et al., 2019). The multimethod approach is also useful for enhancing *discriminant* validity between variables, permitting clearer theoretical distinctions. For example, two psychological variables can be differentiated from each other in terms of neurophysiological indicators such as activation of the dorsolateral prefrontal cortex (Reimann et al., 2018).

By integrating multimethod and reasoning approaches, four viable paths for consumer neuroscientists emerge (Figure 1). It is important to appreciate that no single path holds a monopoly on truth, each has yielded nuggets of insights to consumer neuroscience.

### The excavation path: Single method and inductive reasoning

By focusing on fMRI, consumer neuroscientists can observe patterns of blood oxygenation in specific brain areas in response to a task, and then induce broader psychological meanings. For example, Chen et al. (2015) reasoned that brain regions found active during a

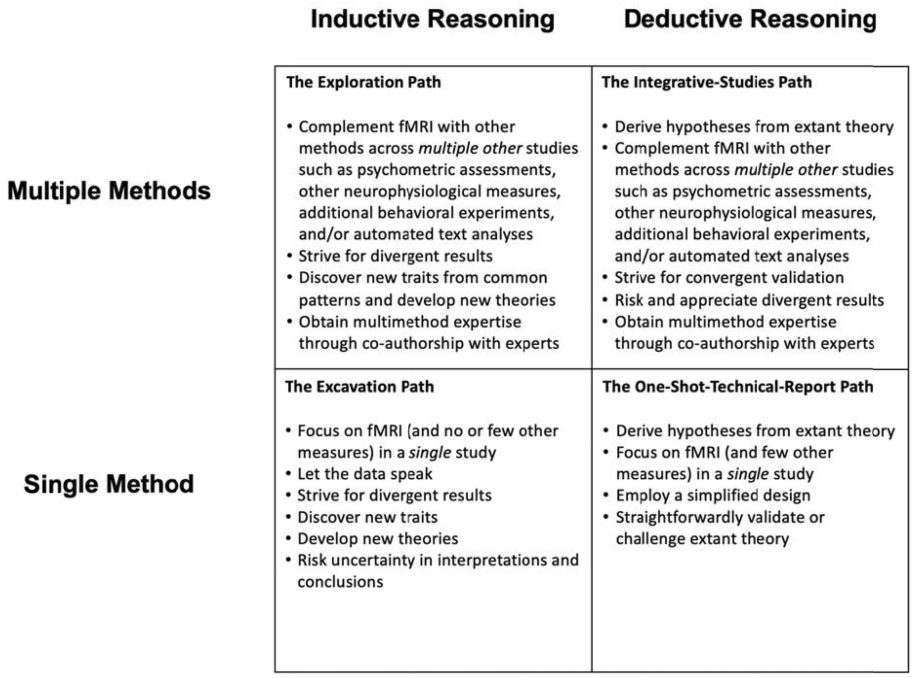


**FIGURE 1** An integration of multi method and reasoning approaches yield four different paths consumer neuroscientists have taken.

brand-personality task are linked to psychological traits such as personality and mental imagery. Furthermore, Chan et al. (2018) associated regions found active during a brand-image task with visual processing, episodic memory, self-awareness, and the default network. While this path is more exploratory in nature, interesting insights have been gleaned from it. It is useful because it can guide consumer neuroscientists to excavate new theories.

## The exploration path: multiple methods and inductive reasoning

By employing multiple methods, such as combining fMRI with psychometric or other neurophysiological measures, consumer neuroscientists have inductively reasoned on the basis of different data sources. For example, Berns and Moore (2012) shed light on the meaning of their neurophysiological results by having fMRI participants respond to a psychometric assessment of the suspected variable. Furthermore, Venkatraman et al. (2015) revealed correlations between psychometric measures, heart rate, and prefrontal cortex activation. Based on these correlates, the authors inductively reasoned that results could refer to attention regulation. This path is useful to develop complementary psychological interpretations and to differentiate between competing ones while overcoming common-method bias. If results do not converge, one can investigate further to determine the source of this discrepancy. This path yields both a rich tapestry of insights and potentially more robust findings.

## The one-shot-technical-report path: single method and deductive reasoning

By beginning with theory, some consumer neuroscientists have focused on a single fMRI study to test specific hypotheses. For example, Esch et al. (2012) built on the well-established theory of the Broca's area to derive their hypotheses about its involvement in linguistics and brand unfamiliarity. Further, Hedgcock and Rao (2009) built on previously established work on the dopamine system to develop hypotheses on the underpinnings of the decoy effect. Moreover, Karmarkar et al. (2015) deduced hypotheses from prior theorizing on the prefrontal cortex and monetary valuation. Further, Cascio et al. (2015) hypothesized that neural systems previously implicated in word-of-mouth and social influence interact when consumers make recommendations. This path is helpful because it starts with an established theory to test concrete hypotheses. To aid such hypothesis development, Turel and Bechara (2021) have proposed a triple-neural-system theory of consumption, which integrates hitherto separate literatures on the amygdala-striatal reward system, the prefrontal self-control system, and the interoceptive-awareness system of the insula.

## The integrative-studies-path: multiple methods and deductive reasoning

By employing multiple methods, consumer neuroscientists have extended the deductive path. For example, drawing from social cognitive neuroscience, Dietvorst et al. (2009) theorized that interpersonal-mentalizing

individuals show more activation in specific brain networks. They validate a new scale across studies and apply it to fMRI. Furthermore, Reimann et al. (2016) built on common-currency theory to study food choice across behavioral and fMRI studies. Moreover, Wiggin et al. (2019) applied multiple methods to illustrate neurophysiological and psychological processes associated with curiosity. This path allows more systematic theory testing. The more multiple methods converge on reasonably similar conclusions, the clearer becomes the theory. On the downside, interpreting multimethod data is complex, and might produce divergent results.

In summary, consumer neuroscience is not confined to one particular path. While it is true that employing various measures to study the same latent variable may potentially result in more robust findings (cf. figure 3 in Clithero et al., 2024), it is important to recognize that taking a single-method path, such as focusing on fMRI, can nonetheless yield valuable insights. It is also worth noting that numerous works in consumer neuroscience took the multimethod path (e.g., Craig et al., 2012; Hedgcock et al., 2012; Reimann et al., 2010, 2018; Warren & Reimann, 2019; Wiggin et al., 2019). As a matter of fact, several papers even combined fMRI with other physiological methods, like Bagozzi et al. (2012) using genetics, Venkatraman et al. (2015) using heart-rate data, and Reimann et al. (2016) employing blood glucose manipulation.

For consumer neuroscience to thrive, it must be inclusive and continue to merge with traditional consumer research. To achieve this, I propose a friendly *Consumer Neuroscience Challenge* for the next 5 years: pick some of the most well-known behavioral experiments in consumer psychology and carry them out while participants undergo fMRI. Do this while training the next generation of consumer neuroscientists (i.e., doctoral students in marketing with a minor in neuroscience). This next generation could present the work at a Society for Consumer Psychology boutique conference, and perhaps inspire another method of dialog.

# BRAINS?

Brian Knutson
Stanford University

## Old goals

Once upon a time in Hollywood, young director James Cameron sought to convince a group of studio producers to fund a new movie. Dispensing with the usual slides, he turned over his script.

| | |
|---|---|
| He first wrote one word: | ALIEN |
| After a pause, he added a letter: | ALIENS |
| Finally, he added a vertical line: | ALIEN$ |

As we now know, the project was funded (Chilton, 2022).

The director's successful strategy implies basic principles for seeking support for a new venture. First, confirm prior success. Second, demonstrate potential generalization. Third, highlight added value.

These principles for inspiring investment might extend beyond entertainment to scientific ventures. For instance, over a decade ago, reviewers suggested that the emerging field of "Neuromarketing" (or Consumer Neuroscience) should strive to replicate (e.g., by supporting robust inference), to generalize (e.g., by revealing hidden information), and to add value (e.g., by offering benefits over existing methods; Ariely & Berns, 2010). The passage of time raises an opportunity to reflect on whether consumer neuroscience has met these desiderata. Though the current review seems to imply that it has not (e.g., "…'consumer neuroscience' has thus far not lived up to its promises…" Clithero et al., 2024), what does the evidence suggest?

## Brain

Can brain activity replicably predict individual choice? Inspired by animal neuroscience and early human neuroimaging studies, researchers used Functional Magnetic Resonance Imaging (or FMRI) to explore whether brain activity can predict choice. Researchers leveraged FMRI for this purpose based on its temporal (on the order of seconds), spatial (on the order of millimeters), and depth (subcortical) resolution for visualizing anticipatory activity in evolutionarily-conserved motivational circuits prior to choice (Bartra et al., 2013; Clithero & Rangel, 2014; Knutson & Greer, 2008). Over a decade of research currently indicates that activity in a few brain regions can predict subsequent choices to purchase products, at a level approximating or exceeding self-report measures (e.g., ~75% vs. 50% chance; reviewed in Levy & Glimcher, 2012). Consistent with comparative research, relevant regions include the Nucleus Accumbens (NAcc; associated with anticipating gains), the Anterior Insula (AIns; associated with anticipating losses as well as gains), and the Medial PreFrontal Cortex (MPFC; associated with balancing anticipated gains versus losses, as well as other considerations including uncertainty and time; Samanez-Larkin & Knutson, 2015). Although questions remain and methods continue to improve, this evidence indicates that localized brain activity can robustly predict consumer choice in individuals. After the first replication, reverse inference transforms into forward inference. In predicting individual purchases with brain activity, although researchers may not have identified a "buy button," they certainly can target activity in relevant "hedonic hotspots."

## Brains

Can neural predictions of consumer choice generalize? After using an individual's brain activity to predict subsequent choices, researchers began to explore whether they could use group brain activity to forecast the choices of other groups of people (sometimes called "neuroforecasting"). Following early examples of neuroforecasting demand for popular music and health advertisements, subsequent studies verified and extended neuroforecasts of consumer demand to other markets (partially reviewed in Knutson & Genevsky, 2018). Remarkably, not only could group brain activity from predictive circuits forecast demand out-of-sample, but it could also do so above and beyond more conventional measures collected from those samples (e.g., subjective ratings or choice). Together, these findings illustrate that neuroforecasting can generalize beyond experimental samples, sometimes even better than commonly measured behavioral variables, but have yet to clarify when or why.

## Brain$?

Can neural forecasts of consumer demand add value? One concrete way to add value is to offer an application with a better benefit-to-cost ratio (Ariely & Berns, 2010). Although neuroimaging methods exact costs in terms of expenses and expertise, they might also confer benefits involving fewer subjects and higher signal-to-noise measurement of mechanisms that drive choice. For instance, a typical FMRI study (e.g., $n \sim 40$ subjects for 1 h each billed at $500.00) currently costs about $20,000.00 (not including staff and subject compensation; Clithero et al., 2024). This estimate does not drastically diverge from the current pricing of focus groups or randomized telephone surveys on larger samples (e.g., $n \sim 2000$ subjects). These estimates will likely change, however, with improvements in design and analysis, and the number of subjects required will depend on the robustness and generalizability of each method.

Another more abstract way to add value is to improve the theory about consumer choice. While the mechanics of neuroforecasting have yet to gracefully meld with existing consumer theory, cumulative findings seem to broadly support accounts that stress the primacy of early implicit affective responses, followed by integration with more deliberative considerations (e.g., Samanez-Larkin & Knutson, 2015). A tantalizing but as yet unrealized possibility is that neural signals might eventually inform researchers not only about which decision components guide specific individual choices but also move different kinds of markets.

## New goals

In summary, consumer neuroscientists have harnessed brain activity to replicably predict individual choices, to generalize forecasts to choices of other groups, and to add value to existing measures. Research therefore appears to have delivered on the desiderata proposed over a decade ago (Ariely & Berns, 2010). So why the pessimism about the contributions of consumer neuroscience (Clithero et al., 2024)? While researchers have met old goals, new goals may have risen to take their place. After demonstrating the possibility of neuroforecasting, researchers can do much more to delineate both the advantages and limits of applications. Any novel measure (central or peripheral, electrical or chemical, and so forth) must still run the gauntlet of satisfying measurement criteria (e.g., reliability, validity, generalizability). An interesting implication of current findings is that measures that are closer to motivational circuits might more rapidly achieve measurement quality. Researchers also now have an opportunity to develop standardized protocols as well as performance benchmarks for evaluating new methods and tracking advances. Approaching the goal of linking levels of analysis, but from a different angle, building from a core set of replicable and generalizable findings may offer the most direct route (Knutson & Srirangarajan, 2019). Theoretical integration has also lagged behind the exploration of applications (possibly reflected by local undercitation; Clithero et al., 2024), and could benefit from greater synergy. Still, the demonstrated replicability, generalizability, and added value of consumer neuroscience would seem to justify the investment. Who will reap the returns of such an investment, however, remains to be seen.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## ORCID

*Martin Reimann* https://orcid.org/0000-0002-3246-1878
*Brian Knutson* https://orcid.org/0000-0002-7669-426X
*Joel Huber* https://orcid.org/0000-0002-6479-2794

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