An Interdisciplinary Lens on Consciousness:
The Consciousness Continuum and How to (Not) Study It in the Brain and the Gut

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Abstract

We welcome Williams and Poehlman’s (forthcoming) effort to better conceptualize consciousness in consumer research. In this comment, our goal is to complement their ideas based on models and methods from cognitive and consumer neuroscience. We extend their suggestions in two important ways. First, we offer an extended framework based on a taxonomy of consciousness from visual neuroscience that suggests a continuum rather than a dichotomy between unconscious and conscious processes. This continuum is determined by the role of perception and attention and the communication between different functional systems in the brain. We then clarify and make suggestions about how different methods from the neurobiology toolbox can be used (or not) as measures of mediating and moderating variables underlying consciousness in consumer behavior.

Keywords: visual consciousness, attention, neuroscience, brain imaging, gut bacteria, functional and structural brain connectivity
We applaud Williams and Poehlman’s (WP) efforts to conceptualize the role of consciousness in consumer research more clearly (Williams and Poehlman forthcoming). The authors propose a novel perspective on consciousness, provide a clearer definition (i.e., consciousness = awareness), and call for more careful evidence when proposing a conscious causation for consumer behavior. Although we are generally sympathetic to WP’s conclusions and believe that their work is of great value to consumer researchers, we see two points for improvement:

(1) The consciousness continuum: A conceptual extension of WP’s new framework based on neuroscientific models of (visual) consciousness that is also in line with Baumeister et al.’s call for a better integration of conscious and unconscious influences and processes in consumer research (Baumeister et al. forthcoming).

(2) How to (not) study the consciousness continuum in the brain and the gut: In light of issues measuring conscious and unconscious influences and processes pointed out by Sweldens, Tuk, and Huetter, we provide a clarification and extension of how the neurobiology toolkit may (or may not) provide additional insights to the consciousness debate in consumer research (Sweldens et al. forthcoming).

THE CONSCIOUSNESS CONTINUUM: AN EXTENDED TAXONOMY FROM NEUROSCIENCE

WP’s improved framework suggests a simple dichotomy of conscious versus unconscious influences on several key mental operations (i.e., control, deliberation, intention, and effort). This dichotomy, and their novel definition of consciousness = awareness, is based on their systematic examination of the field’s key journals and terms related to conscious processes.
However, to be able to decide when and how we should study conscious versus unconscious processes in consumer behavior, we need to better understand what “unconscious” means in this context and how these terms are related. To provide a comprehensive overview of how consciousness is studied and why we should focus more on unconscious processes, a parallel search for the terms “unconscious,” “nonconscious,” “subconscious,” “preconscious,” and “subliminal” is needed. We thus performed such a search, and propose an augmented framework that provides further clarifications on the definition and nature of conscious and unconscious influences and processes.

We followed the same methodology as WP and examined papers published in the same four top marketing and decision-making journals, during the same time range, using the same databases. We identified 189 papers that include the word “unconscious,” 127 articles that include “nonconscious,” 38 articles that include “subconscious,” 22 articles that use “preconscious,” and 71 articles that mention “subliminal,” for a total of 447 articles that refer to processes other than conscious processes (compared to 220 articles WP identified that use consciousness terms).

Importantly, our literature search shows that various terms are being used to refer to what WP call “unconscious processes.” WP do not discuss these differences and the multitude of processes that fit under their term “unconscious.” We suggest that more conceptual work is needed to clarify what these terms mean and propose the seminal framework by Dehaene et al. from visual neuroscience as a starting point (Dehaene et al. 2006; see figure 1).

Dehaene et al.’s framework is based on the global neuronal workspace hypothesis (Baars 2002; Dehaene and Naccache 2001; Koch and Tsuchiya 2007) proposing that, simply put, the level of consciousness of a visual stimulus depends on the level of communication or
connectivity between the brain’s primary visual system (see figure 1 in orange) and other functional subnetworks within the visual system, extending to object and spatial recognition as well as memory systems via short-range communications (see figure 1 in green) and longer-range communications with higher cognitive systems important for executive functions, including cognitive control and valuation (see figure 1 in blue). Importantly, it suggests that there is no clear dichotomy between unconscious and conscious processes but that they occur on a continuum. On a neural level this continuum depends on the level of communication between sensory systems (here visual input in the primary visual system; an extension to other senses is possible) and other associative brain systems (e.g., the motor system or the brain’s valuation system). On a conceptual level this continuum depends on whether a stimulus is perceptible and how attention is deployed (see figure 1).

Insert Figure 1 about here

On one end of the continuum are subliminal processes that are characterized by very little activation in the brain’s primary visual cortex and are below the level of perceptibility.¹ A typical example of a study within this category is that of subliminal primes (Fitzsimons, Chartrand, and Fitzsimons 2008).

Next on the continuum, consistent with Dehaene et al. (2006), are a set of processes that are above the level of perceptibility and are likely a result of intense activation in the complete visual system, allowing perception by extending to object and spatial recognition and also memory systems, yet go mostly unnoticed because attention is engaged elsewhere. Thus,

¹ Dehaene et al. (2006) describe two different sets of subliminal processes: those that are unattended and those that are attended and can receive various depth of processing and can reach semantic level. For the sake of simplicity for consumer research applications we summarize them here in one category.
communication to higher cognitive systems is blocked. For example, a consumer may see a piece of chocolate cake and be aware of his goal to eat healthfully, but his lack of attention to that goal—and thus the lack of communication with higher cognitive processes linked to self-control—makes the healthy goal stay in the preconscious domain. This is an example of the set of processes that WP refer to as “unconscious.” However, we argue that the term is confusing because unconscious processes can also include subliminal processes. We suggest that the term “preconscious” (Dehaene et al. 2006) is a better descriptor of the processes WP label as “unconscious.” Importantly, we propose that this term is a more accurate descriptor of the underlying processes and that it should be used in the consumer research literature instead of a plethora of other terms (i.e., nonconscious, unconscious, subconscious; see the above literature search).

Finally, on the other end of the continuum are conscious processes that are both above the level of perceptibility and currently attended to. They are characterized by amplification of brain activity and its spreading to other, higher-level brain areas in the prefrontal cortex important for decision making and its control (Dehaene et al. 2006). To stay with the above example, attention is the key process that moves consumers’ goals (i.e., to eat healthfully) from the “preconscious” to the “conscious” realm. This means that we need to examine how various mental operations (e.g., control, deliberation, intention, effort, etc.) are affected by where along the conscious continuum they fall. This is consistent with WP, but instead of suggesting that all primary consumer operations have both conscious and unconscious aspects, we suggest that these operations fall at the various points of the consciousness continuum at various times during the decision-making process.²

² Our framework based on visual neuroscience models of visual consciousness is similar in its nature to some other models of information processing in the consumer research literature. For example, Greenwald and Leavitt (1984)
The above discussion emphasizes the fact that attention plays a key role in moving mental processes along the consciousness continuum, yet attention receives little space in WP and is in general under-researched in consumer psychology (Milosavljevic and Cerf 2008). For example, WP state that there is a dissociation between consumers’ awareness of mental processes and their ability to control these processes. Specifically, they explain one’s failure to adhere to the healthful eating goal as a self-control conflict (e.g., staying healthy vs. eating a cookie). These types of explanation should give more weight to the role of attention; that is, it is the consumer’s lack of attention to the health goal—and as a result the lack of communication with higher cognitive processes in the prefrontal cortex that are linked to self-control—that keeps the health goal in the preconscious domain.

More research is needed to examine the role of attention within the consciousness continuum—that is, to better understand the influences and processes that consumers are aware of but that are not receiving attentional spotlight (i.e., the processes that stay in the preconscious domain). And more specifically, we need to understand when and how key mental operations move from one domain to the other in the course of consumer behavior.

In addition to defining consciousness and unconsciousness not as a dichotomy but rather as a continuum, we also agree with Sweldens et al.’s (forthcoming) request that consumer researchers need to be more specific about which parts of the decision-making processes they are studying. In other words, it is crucial for consumer researchers to be clear about the process level they are investigating—that is, whether they are predicting that an external or internal influence is conscious (or subliminal or preconscious) or that the evaluation process itself is conscious (or

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describe four levels of audience involvement in advertising; Raghubir (2008) lays out a visual information processing model. Our hope is to provide a starting point to reconcile differences in terminology and definitions across such models as well as to provide a more general consumer consciousness framework that should be relevant across various areas of consumer research, including but not limited to the examples mentioned above.
subliminal or preconscious). We suggest for this purpose that the adaptation of the lens model, as done by Newell and Shanks (2014), is an excellent starting point to clarify various loci of conscious influences.

We hope that future researchers will use and further develop the consciousness continuum framework suggested here and clearly identify where the processes they are studying fit within this continuum. Doing so will not only ease knowledge building and allow researchers to clearly communicate which individual processes they are studying but will also allow them to begin studying how some of these processes may interact (Laran 2016).

**HOW THE TOOLKIT FROM NEUROBIOLOGY MAY HELP (OR NOT)**

WP suggest adding various neurobiological markers to the toolkit of consumer researchers to enable them to better understand the role of consciousness in consumer behavior. This call seems intuitive because neurobiological measures may allow inferences without reliance on (potentially consciously biased) self-reports, and in general, we are supportive of this intuition (Plassmann and Karmarkar 2015; Plassmann, Ramsøy, and Milosavljevic 2012). However, we also strongly encourage researchers to apply a multi-method approach that combines self-reports with methodological approaches from neurobiology, being aware of their strengths and weaknesses and appropriateness for which consumer research questions (Plassmann et al. 2015).

This is in line with Sweldens et al.’s (forthcoming) call for multiple operationalization of awareness and Baumeister et al.’s (forthcoming) comment on the importance of self-reports for consumer research. We also agree with both of their requests that as a field we need to agree on
standardized criteria to establish consciousness, such as those proposed by Newell and Shanks (2014)—reliability, relevance, immediacy, and sensitivity—and believe that neurobiological tools could contribute to act on these criteria in important ways, as outlined below. However, contrary to what WP suggest, not every neural pathway needs to be “low level” in the sense of whether it correlates with conscious, preconscious, or subliminal processes as outlined above. Thus, we find WP’s description of how neurobiological markers could be useful misleading at times.

Next, we would like to clarify how neurobiological markers could indeed shed new light on the consciousness debate in consumer research. More specifically, we suggest integrating neurobiological markers for the study of consciousness in two ways: (1) as real-time measures of mediating processes and (2) as more trait-like individual difference measures.

Real-Time Neurophysiological Measures as Mediators of Consumer Behavior

This section is based on the notion that most neurophysiological measures, such as brain imaging, eye-tracking, and psychophysiological measures, allow for the measurement of 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 (for more detailed description of the neuroscience toolkit see, e.g., Kable 2011; Plassmann and Karmarkar 2015). In these periods, important information processes are taking place that are crucial to better understanding of consumer behavior. These measurement characteristics of neurobiological markers are extremely powerful, considering Newell and Shanks’ (2014) proposition that consciousness measurements should be temporally near the outcome (immediacy) and elicited by
the same cue as the outcome (sensitivity). These characteristics are also important because they
shed light on the information processes and how they interact, which is important when
attempting to understand psychological mechanisms (subliminal, preconscious, and conscious
ones) and their choice architecture (Weber and Johnson 2009).

An interesting recent development has been the approach of testing whether
neurophysiological measures formally mediate behavior or self-reports from consumers. This
approach was first used with brain imaging data to test brain mediators of pain placebo effects by
Tor Wager’s lab (Atlas et al. 2010; Atlas et al. 2014). For this purpose, his group developed a
freely available single- and multi-level mediation toolbox (http://wagerlab.colorado.edu/tools).

A similar approach has recently been used by consumer researchers. For example,
Mormann et al. (2016) examined how consumers form reference points and use eye-tracking as a
measure of mediating processes—that is, attention to various past prices. While the existing
literature focuses on the stream of previous prices (Briesch et al. 1997; Weaver and Frederick
2012; Winer 1986), Mormann et al. showed that how much consumers use specific past prices in
forming their reference points depends on the amount of attention these past prices receive, as
measured via eye-tracking (Mormann et al. 2016). They then showed that attention to high prices
can shift the reference point up and that attention to relatively low prices can shift it down.

Other examples include studies from Plassmann’s group that used this approach to
understand, for example, how valence (as measured by facial affective muscle response) and
arousal (as measured by skin conductance response) in response to an incidental affective cue,
such as a surprise monetary gain, mediates an increase in subsequent preferences for unrelated
objects, such as wines or pictures (Ling, Shiv, and Plassmann forthcoming). A last example is

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3 Needless to say, depending on the experimental setup, neurophysiological measures also act on reliability (as they
are based on physiological changes they are tentatively less biased, specifically considering the standard of using
repeated measures designs) and relevance (as a function of using appropriate control conditions).
the study of brain mediators assessed with functional magnetic resonance imaging (fMRI) to investigate why hefty price tags increase consumers’ enjoyment of wines (Plassmann et al. 2008). Brain mediators of such “placebo effects of pricing” include neural signatures of wanting, liking, and cognitive regulation (Schmidt et al. 2016).

Neurobiological Markers of Individual Differences in Consumer Behavior

WP suggest that trait-like neurobiological markers such as prenatal testosterone levels and increased levels of specific gut bacteria could serve as relevant individual differences affecting consumer behavior that are not consciously accessible by the consumer. We strongly agree that there is potential merit in investigating individual differences on the basis of neurobiological markers. We also believe more generally that predictions of behavior that are further from the context where the data were collected, in terms of stimuli or time, could be of even more practical use in answering marketing questions, such that they might help to identify different types of consumers (Kable and Levy 2015; Venkatraman et al. 2012).

In what follows we point to more recently established markers that also tie into the idea that consciousness depends on the level of communication or connectivity in the brain (as conceptualized in figure 1) and extend this notion with first findings on the communication between the gut and the brain. We focus specifically on four kinds of measures: measures of gray matter volume, measures of structural connectivity, measures of functional resting-state connectivity of the so-called “default-mode network,” and new findings about gut bacteria–brain communication.

Measures of Gray Matter Volume. Differences in brain structures, such as gray matter volume, can be linked to individual differences in brain function, personality, and behavior, in
both health and disease. The basic assumption underlying such approaches is that regional gray matter volume, as measured by structural magnetic resonance imaging (MRI), corresponds to the regional volume and wiring of nerve cell layers in the brain. This approach has recently been applied to predict individual differences relevant for consumer behavior (Gilaie-Dotan et al. 2014; Plassmann and Weber 2015). For example, Plassmann and Weber (2015) applied this approach to explore brain regions that showed a variation in gray matter volume that predicted individual differences in how much high prices and indulgent product claims enhanced consumers’ enjoyment of wines and milkshakes. They then used the neurobiological individual difference marker to inform follow-up behavioral experiments that shed more light on the personality traits linked to the functioning of these brain regions. Their findings showed that consumers high in reward-seeking, low in somatosensory awareness, and high in need for cognition were more responsive to the effects of marketing.

Measures of Structural Connectivity. If consciousness is a function of connectivity between brain regions, then individual differences in how the brain is wired—as assessed by a technique called diffusion tensor imaging (DTI)—could be a relevant neurobiological marker of individual differences in consciousness of consumer behavior. Simply put, DTI measures the range and strength of white matter connectivity (Johansen-Berg and Rushworth 2009; Mori and Zhang 2006). Several studies have applied this technique to the study of consumer decision-making and found that the structural connectivity in the brain’s valuation system can, for example, be linked to delay discounting (for a review, see Kable and Levy 2015). As an example, van den Bos et al. (2014) found that the extent of delay discounting was negatively correlated with the strength of connection between a region involved in self-control (the dorsolateral prefrontal cortex) and a region involved in reward prediction and motivation (the
striatum) and positively correlated with the strength of tracts from the regions involved in the coding of emotional intensity (the amygdala) to the same region involved in reward prediction and motivation (the striatum) (van den Bos et al. 2014). These findings give first evidence for the idea that weakened structural communication between the neural signatures of self-control and reward-related regions and stronger communication between neural signatures of emotional intensity and reward-related structures may increase preference for immediate rewards.

*Measures of Resting-State Functional Connectivity.* In addition to the two types of anatomical markers described above, functional neural connectivity at rest can also be predictive of individual personality traits and cognitive abilities potentially outside the realm of consciousness. Brain activity at rest has been more popularly referred to as the brain’s so-called “default-mode network” (Biswal et al. 1995, Buckner, Andrews-Hanna, and Schacter 2008; Raichle et al. 2001; Shulman et al. 1997). The default-mode network (DMN) describes the brain’s ongoing or intrinsic activity when participants are asked to do nothing—and thus in the absence of tasks that require deliberative processing. Its neural signatures overlap with those of mind-wandering, thinking about the self and others, remembering the past, and planning for the future (Raichle 2015). It also has overlaps with the brain’s valuation system, which is important for consumer decision-making (Bartra, McGuire, and Kable 2013).

Interestingly for consciousness researchers, general features of the DMN have also been identified in animals—including monkeys, cats, rats, and mice—that clearly differ with respect to their (conscious) mental states. Further, the DMN has been shown to be negatively correlated with the brain’s attention networks (Broyd et al. 2009; Fox et al. 2005). Finally, patterns of resting-state functional connectivity are also present under anesthesia (Greicius et al. 2008) and during the early stages of sleep (Fukunaga et al. 2006; Larson-Prior et al. 2009). These
observations make it unlikely that the DMN represents primarily the result of unconstrained, conscious cognition (Raichle 2015).

For example, first research related to consumer behavior found evidence for a negative correlation between delay discounting and the functional connectivity among regions that have been implicated in self-control and reward-related structures important for the choice process (Li et al. 2013). These findings support the notion that weakened communication between the neural signatures of self-control and reward-related regions may increase preference for immediate rewards.

_Measures of Gut Bacteria–Brain Connectivity._ Another new development is our improved understanding of the role that the gut (the “second brain”) plays in influencing consumer behavior—most likely taking place beyond the realm of consciousness. One recent discovery is the “new organ” in our gut: the trillions of bacteria that colonize our intestines. A lot of research has been dedicated to how various psychological decision theories, formal models, and neural correlates can explain and predict what we eat and how we regulate food intake (e.g., what, when, and why we prefer the healthy apple over an immediately rewarding, yet unhealthy, piece of chocolate cake). What about the other direction: Does what we have been eating affect who we are and how we make decisions? Recent evidence suggests that what we eat (Cotillard et al. 2013), combined with various factors in our environment (Cryan and Dinan 2012), shapes our gut bacteria. Different gut bacteria profiles influence gut–brain communication (for extensive reviews see Collins, Surette, and Bercik 2012; Mayer 2011), which in turn affects both our emotional responses, such as mood and stress, and how we decide (Mayer 2016; Mueller et al. 2012; Simpson et al. 2005). First work in this area indicates that an increased gut bacteria (gene) richness can be linked to better health (e.g., lower body fat) and psychological well-being.
Although this research is exciting and potentially has an important impact on consumer behavior, it is still in its infancy. Most of the studies have been conducted in rodents, and mechanisms in humans remain essentially unclear. Although first dietary interventions as described by WP indeed may increase gut bacteria diversity in humans for a short period of time (gut bacteria is mostly stable during adulthood and variable only during early childhood and late adulthood), the impact of gut bacteria diversity on questions related to consumer behavior is still unknown. For example, the study by Tillisch et al. (2013) referred to by WP did indeed show in a very small sample of participants that a probiotic diet might increase emotional responding. However, the authors did not find an impact of the intervention on gut bacteria, and hence the effects could be due to a variety of other factors, including a placebo response to the dietary intervention (Tillisch et al. 2013). This is why consumer researchers at this stage cannot make reverse inferences on gut–brain links using dietary interventions but need to measure gut bacteria using fecal samples to make any scientifically grounded claims.

The same is essentially true for hormonal influences. For example, findings that prenatal levels of testosterone matter for consumer behavior are also inconclusive. A recent large-scale testosterone intervention study found an impact of testosterone on several processes related to consumer behavior, such as cognitive reflection (Nave et al. 2016) and status signaling (Nave et al. forthcoming), yet prenatal testosterone levels did not moderate these effects.

Though still early in development, taken together the neurobiological markers outlined in this comment could prove to be very useful for the goals of consumer researchers and other behavioral scientists interested in consciousness research.

RECOMMENDATIONS AND CONCLUSION
We greatly appreciate WP’s efforts to more clearly conceptualize the role of consciousness in consumer research. Their paper undoubtedly makes an important contribution to consumer research. However, we believe that their ideas about the conceptualization and the measurement of consciousness could be refined and extended based on models and methods informed by the study of consciousness in cognitive and consumer neuroscience. More specifically, in this comment, we first suggested an extended framework based on a taxonomy of consciousness from vision neuroscience that suggests a continuum rather than a dichotomy between unconscious and conscious processes, determined by the role of attention and the communication between different functional systems in the brain. Importantly, we proposed that “preconscious” influences and processes should be integrated in concepts of consumer researchers (rather than other currently used terms, such as “nonconscious,” “unconscious,” and “subconscious”). We then clarified and made suggestions about how different tools from the neurobiology toolbox could be used (or not) as measures of mediating and moderating variables underlying consciousness in consumer behavior.

Finally, we applaud WP’s recommendation that marketing Ph.D. students should receive training in cognitive neuroscience. However, acquiring some basic knowledge through classes is not as good as years of research. That is why we suggest that in addition to acquiring some basic levels of understanding through classes, those interested in using the theories and methods of cognitive neuroscience should seek collaborations with experts in that area. For example, consumer researchers interested in consciousness can seek collaborations with cognitive neuroscientists and microbiologists to understand gut–brain–behavior links relevant for consumer research. Collaborative, interdisciplinary research is often cited as a goal of
departments, schools, universities, and journals, and a mix of coursework and research collaborations may prove to be a winning strategy in achieving that goal.
Figure 1: The consciousness continuum, adapted from Dehaene et al. (2006). Three types of consciousness states are schematically shown, defined by whether a stimulus is perceptible in the primary visual cortex and whether awareness and attention are present. Colors illustrate location of strongest activation (primary visual cortex = orange, other parts of visual cortex extending to temporal and parietal cortex = green, parieto-frontal and pre-frontal cortex = blue), and small arrows illustrate communication between them. Large arrows schematically illustrate whether attention is paid to the stimulus.
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